AN INTRODUCTORY STUDY OF THE ACARINA, OR MITES, OF OHIO

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AN INTRODUCTORY STUDY OF THE ACARINA, OR MITES, OF OHIO*

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INTRODUCTION

In the animal kingdom few of the larger orders can be mentioned about which less is known than the Acarina, or, as they are popularly spoken of, the mites. The almost universal lack of knowledge of this group is undoubtedly explained by the minute size of its members, their obscure habits, and the comparatively few forms that are of economic importance. One group, the ticks, may as a whole be excepted from this general statement for its members are uniformly of large size, parasitic upon domestic and other animals, instrumental in the transmission of infectious diseases of man and animals, and accordingly of pronounced economic importance. Among the other larger groups of the order Acarina, but few species in each are generally known. These may consist of isolated species in the group, or perhaps of a genus or subfamily of but a few species, and these usually are of economic importance. Otherwise, descriptions, and these often most unsatisfactory, comprise the bulk of the literature dealing with this highly interesting group of animals.

Linnaeus in his Systema Natura of 1758 lists several species of mites and appends exceedingly brief descriptions. As most foreign literature was not readily accessible to English students, we find that much of the early acarology of England and the United States was based upon the part of Murray's "Economic Entomology, Aptera" of 1877 treating with the Acarina.

The individuals who have devoted a comparatively long period of time to an intensive study of the mites are few. The majority

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of them have lived and worked in Europe, and consequently the mite fauna of that continent is much better known than that of any other. The student intending to prosecute intensive research in this group should first thoroly acquaint himself with Canestrini's *"Prospetto dell' Acarofauna Italiana"*, and follow this with an exhaustive review of the numerous and valuable contributions of a later Italian worker, Antonio Berlese. The works of C. L. Koch, P. Megnin, E. L. Trouessart, F. Koenike, L. G. Neumann, P. Kramer, I. Tragardh, S. Thor, A. Nalepa, and A. C. Oudemans of the continent and A. D. Michael, S. Hirst, and G. F. Nuttall of England are invaluable to students of acarology in the respective fields of each of these authors. In the United States there are four individuals who have contributed in a comprehensive manner to the knowledge of our Acarian fauna; Dr. H. E. Ewing of the National Museum and Dr. Nathan Banks of Harvard University, working in the terrestrial groups; and Dr. Ruth Marshall of Rockford College and Dr. Robert Wolcott of the University of Nebraska, undertaking the study of the aquatic mites. Dr. Banks and Dr. Wolcott are no longer engaged in active work on the Acarina.

Having spent much time during the last several years in the field study of insects, I became interested in our minute mite fauna, which is often very closely linked with the insect fauna. The subject being but slightly investigated, I was led to present this introductory study of the Acarina of Ohio.

The collections of Dr. H. Osborn, the Ohio State University, and the Ohio Experiment Station yielded scarcely 75 slides, many of which were rendered useless because of the deterioration of the mounting medium. A general collection of 25 slides made by C. K. Brain at Cedar Point, a few records of Eriophyidae by Cook and Wells, and a few new species and others recorded by Dr. Ewing formed the basis of this work. The entire literature did not comprise more than 100 pages. This should not lead one to conclude that the mite fauna of Ohio will be found totally different from that found elsewhere in the Austral Zone. My personal collections and notes were made over a period of several years with Chillicothe, in south-central Ohio, as the locality. In this discussion I shall review the technique usually employed in acarology and present those forms known to Ohio with such notes as will enable one to more easily recognize them.

Before continuing with this subject I wish to acknowledge my indebtedness to Dr. Herbert Osborn, Dr. H. E. Ewing, Dr. Ruth Marshall, Dr. R. C. Osburn, and Prof. H. A. Gossard for the

encouragement each has given me and for the specific manner in which each has further contributed to whatever merit this paper may possess.

METHOD OF APPROACH

Any investigator appreciates the value of as extensive a library as the means at hand will permit. Because of the comparatively small volume of literature dealing with the fauna of the United States it was not difficult to secure the more valuable contributions to acarology. Access to several of our larger libraries made accessible the more important foreign contributions. A card bibliography of all literature dealing with the Acarina, altho not complete, comprises upwards of 6,000 references. This will at once suggest the difficulty confronting anyone endeavoring to place all the literature of this group within one library.

To become the master of an order in the plant or animal kingdom has ceased to be within the realm of possibility for most individuals. With few exceptions an order includes such a diversity of forms with such varied habits that most workers must be content with the acquisition of a general knowledge of the entire group and, in the course of time, with the isolation of some smaller portion upon which to focus a more detailed study. The Acarina, constituting a very large order, must of necessity be attacked in this manner. Thus far I have made collections to the extent of more than 1,000 slides. This material represents many families in all of the seven superfamilies. Such a range evidences the method used in collecting, and reference to the habitat notes accompanying each species will throw further light upon the source of material. For one desiring a broad general knowledge of the Acarina such a random collection over several years will serve admirably.

After having isolated several species upon which to center special study, it was the program of each collecting trip to carefully examine the bark crevices on trees; the areas beneath fallen debris of all kinds; the areas beneath loose bark; the galleries of burrowing insects and rodents; the malformations and discolorations of leaves, flowers, and fruits that might come within range of the eye; and all insects or other animals that could be caught, as these might harbor parasites. Many species are also of common occurrence in food products, whether stored or offered for sale, and in clothing, furniture, etc., while others frequent decaying material of various kinds. Several large groups, found as parasites on the more elusive animals and undoubtedly well represented in Ohio,

are not recorded here because I, as others, have not taken the time necessary to secure them. Aware of the rich aquatic fauna present in adjoining states, I made a short collecting trip to Buckeye Lake in Ohio and there captured most of those aquatic Acarina herein recorded.

The technique involved in preservation and preparation for study is still far from perfected for all groups. When living specimens are to be mounted they may be killed in hot water, which usually leaves the appendages extended. Dehydration and mounting in several different media, depending upon the chitinization of the integument, then follows. For those heavily chitinized forms, such as adult *Oribatoidea, Parasitoidea, Ixodoidea,* and the like, a good grade of Canada balsam answers very well. The fact that this medium darkens with age is one serious objection to its use. For soft bodied species balsam has that undesirable property of causing the body to shrink and thus obscure many of the more minute characters. Sodium silicate has been suggested to eliminate this difficulty but, after examining some material mounted in this medium, I cannot recommend it as suitable except for temporary mounts.

A medium that I have used with considerable satisfaction for all forms is glycerine jelly. This is composed of 50 cc. of glycerine, 42 cc. of water, 6 cc. of melted or dissolved gelatin, and 2 cc. of carbolic acid. The latter serves to destroy any fungus organisms that might otherwise find the material a suitable culture medium. A small well approximately the diameter of the cover glass to be used is made on the slide with gold size. It is well to prepare a large number of these in advance so that they may become thoroly dry before being used. I have found that this material preserves the natural color of the mite for some time; it does not cause shrinking of the body; the appendages are nicely distended, altho the specimen has not been killed in hot water; and the mite remains soft and easily manipulated, if such be necessary. The sole objection that I have found to glycerine jelly after several years of use and an examination of many mounts of other workers is the necesity of protecting it against slow evaporation. After the cover glass has been put in place the slide is set aside to dry. When the jelly has set and the cover glass edge is dry a ring of damar varnish, white lead, or some other suitable material is run around it. If the material is thin this may have to be repeated. As this ring hardens it develops minute cracks and pores thru which the glycerine preparation slowly evaporates. Slides prepared by some of our

most exacting technicians have not been free from this difficulty. It is therefore necessary to examine glycerine mounts at least once each year and to apply a fresh layer of the ringing material to those showing any deterioration. It may often be found necessary to remount some valuable specimens because deterioration has progressed to such an extent that mere reringing will not prevent their loss.

Some mites may be successfully cleared in warm KOH and then stained as is the practice with the Coccidae. So little has been done with this method that details will be omitted here. Euporal has been used to a slight extent and seems to be as satisfactory as balsam. Gum arabic is sometimes added to the glycerine jelly to give it more body. Time alone will prove or disprove the value of these materials.

Where possible duplicate material should always be preserved in vials. A 75 or 85 percent alcohol has long been the standard material to use. All workers soon learn that alcoholic material is hard and in time becomes colorless. Thru evaporation many valuable collections preserved in alcohol have been lost. Wishing to eliminate as many of these faults as possible, I have employed a mixture of 1 part glacial acetic acid, 1 part glycerine, and 1 part water as a preserving medium. I believe it to be preferable to alcohol in several respects: the specimens remain soft and pliable; retain their color for a considerably longer time than those in alcohol; and altho evaporation takes place, it does so but slowly and thus decreases the possible loss thru this channel.

Altho it may seem needless to emphasize the accurate and complete labeling of slides and the maintenance of accurate and detailed notes, I take this opportunity to do so, prompted by the difficulties that I have experienced in studying many slides whose value was small due to a lack of adequate data.

In field collecting I have found a fine brush or a moistened splinter to serve adequately in picking the mites from their habitat. When the student wishes to prosecute biological studies, the mites and a little of the substrata should be removed to the laboratory. Otherwise they may be killed immediately. For rearing work I have used small vials or sections of these mounted on slides and sealed down with gold size. A bit of moist blotting paper with a little suitable food material maintains the mite in a suitable environment and presents an easily studied rearing cage.

Many parasitic species do not leave their host upon the death of the latter and these may be collected from preserved skins in

museums or other repositories. For general field collections a Berlese trap has been found indispensable. The Birge collecting net is very satisfactory for aquatic collecting. Aquatic mites, the Hydrachnidae, have a tremendous vertical distribution, and to secure a representative collection the student must not fail to take this into account.

PHYLOGENETIC POSITION

As one reviews the early studies of the Acarina he is at once impressed by the confusion that has existed as to the exact position that the group should occupy in the phylogenetic tree. It has usually been credited with ordinal rank and is so recognized today. Since most of the species are hexapodal during their larval stages they have frequently been grouped with the Insecta. An apparent segmentation of some species has fortified this placement. As adults most of them are octopodal and superficially may resemble spiders. Doubt as to the exact ancestry of the group has often led to uncertainty in placing the Acarians. In 1913 Dr. Ewing presented an arrangement of the Acarina dividing them into six quite distinct suborders, and these into eight sections. Altho not the latest scheme to be offered, I shall use it in treating our Ohio mites.

A practice which has tended to confuse the relationship of the Acarina in the lay mind and to a certain extent in that of the beginning student is that of thotlessly speaking of some of the more common forms as "insects" or "bugs". The name "lice" is also frequently applied to some of the parasitic forms. Since the entomologist has often been left to deal with both insects and mites it is natural that such a generalization of names should have come into use. Since the term "mite" is as appropriate for common usage and as easily understood as is that of "insect" or "spider", it should be adopted by biologists to designate the acarina, which are not in any sense insects.

Like the spiders, the body in all the Acarina is divided into two parts, which are usually broadly fused so that in some cases no actual distinction can be made. The anterior part, or cephalothorax, bears the mouthparts, either terminally or ventrally; the anterior pairs of legs; the eyes, when present, and other organs of yet unknown function. The eyes are usually near the lateral margins and occur in one or more pairs which may be either sessile or stalked. There is seldom the median pair of eyes as in the Phalangids.

The cephalothorax may be further divided into an anterior portion called the rostrum and a posterior portion called the dorso-vertex. The former is the result of the fusion of the mouth segments, altho this is often quite difficult to discern. Because of the usual fusion between the abdomen and the cephalothorax it is difficult to accurately limit the dorso-vertex. Ventrally, or approximately so, the cephalothorax shows the oral cavity containing the mouthparts. Chitinous projections arising from the cephalothorax, the epistoma above and the hypostoma below, frequently protect the oral cavity. The mouthparts consist of the mandibles and palpi, either of which may be variously modified, and usually one or more other parts such as the maxillae, or hypopharynx.

The abdomen, or posterior portion of the body, usually seems to bear the two posterior pairs of legs, sometimes large humeral bristles, and the external genital apparatus. The latter, if present, will be apparent on the ventral surface. Seldom are there any apparent subdivisions of the abdomen. The fact that the abdomen appears to bear the posterior pairs of legs when these are present may be accounted for by the total fusion of a portion of the cephalothorax actually carrying these appendages with the abdomen. Occasional species show traces of apparent segmentation.

As suggested previously there are numerous species of the Acarina that take a heavy toll from those things required by man in satisfying his various needs. A few species are parasitic or temporarily so upon man. Many such species or representatives of the same genus are almost cosmopolitan in their distribution. For many years entomologists have been called upon to devise some satisfactory control for these troublesome, and oftentimes almost invisible, organisms. For most of the more important ones quite successful control measures have been devised, while for others there is still too little known of their habits and susceptibilities to permit of the effective checking of their depredations.

In the following pages the various species of mites, both injurious and beneficial, that have been recorded from Ohio will be discussed and the latest control for the injurious forms will be given. Similar species of major economic importance occurring in other parts of the world will be noted in order to better enable the reader to estimate the importance of this group of animals.

Suborder PROSTIGMATA
Section ADACTYLOGNATHA

This section, together with that of the Dactylognatha and Hydracarina constitute the suborder Prostigmata, a group in which the tracheae are always present and open near the base of the chelicerae; the abdomen is unsegmented. In the Adactylognatha the last palpal segment never forms a thumb to the preceding; the legs do not possess swollen tarsal segments; and the members of this group are as a whole very agile and capable of moving backwards and sidewards as well as forwards. Specimens may also be observed to make short jumps when they are disturbed. In this country representatives of but three families are known and only two of these are thus far recorded from Ohio.

Family Eupodidae

This family contains a number of genera of quite small mites. Some are very common. All are soft-bodied, delicate forms and, because of their great agility, are often difficult to capture without injury. The general characters are a rather distinct division of the body into cephalothorax and abdomen; a single pair of eyes; but few hairs on the body; short, four-segmented palpi; small chelate mandibles; and moderate to very long legs of six or seven joints, terminating in two claws and frequently a pulvillus. They are common at high altitudes, in caves, and among fallen leaves and other debris. They prefer decidedly damp habitats. Their food consists principally of small arthropods and their eggs.

These mites deposit their eggs, as far as is known, upon the surface frequented by the adults. The larvae are hexapods and the nymphs octopods. The latter resemble the adults very greatly. Sexual dimorphism is not distinct. The color range within a species is quite wide due to food recently ingested and to the age of the individual.

The species thus far recorded from the United States fall into six genera. Species of *Notophallus,* a few of which occur in this country, and those of *Penthaleus,* have been found to injure plants by sucking the juices much in the same manner as do the *Tetranychidae. Notophallus* is also peculiar in that it has the anal opening on the dorsum. The other genera of this family include predaceous forms. A species of Tydeus is of no little economic importance from its habit of preying upon the oyster-shell scale.

From Ohio the following representatives of this family have been recorded.

Linopodes antennaepes Banks
Trans. Amer. Ent. Soc., XXI, 1894, p. 221

From early May to late September numerous specimens, ranging in color from milky white of the younger ones to pale mottled brown in the more mature ones, were taken about rotting stumps and logs and from beneath fallen leaves and other debris in wooded areas about Yellow Springs, Chillicothe, and other points in southern Ohio. None were observed feeding. Upon exposure to the light they exhibited a negative phototropic tendency, scurrying to the cover of some dark crevice. It is probably the nymphs and adults that hibernate.

The fore legs are unusually long and seem to be in constant motion no matter in what position the mites are observed. This continuous palpitation would suggest at least a tactile function and possibly one of olfaction.

The species is probably well distributed thruout the State. It has been recorded from Canada to the Gulf and from New Hampshire to Colorado. The habitat is always recorded as a damp one beneath fallen leaves or debris.

Rhagidia pallida Banks
Trans. Amer. Ent. Soc., XXI, 1894, p. 222

A few specimens of this species were taken during May and June. One specimen was taken running about among a mass of webs and larvae of *Crambus caliginosellus* dug from a corn field near Chillicothe. This specimen was of a distinctly greenish-white hue. A number of specimens were taken among fallen leaves and debris in woods near Chillicothe. These were all milky white or hyaline in color and very delicate. Adults range from .7 to .8 mm in length. As noted by Banks, this species greatly resembles certain Solpugidae of the genus *Rhax*, and this suggested to Thorell the generic name. Banks suggests that it is probably the most primitive of existing mites and indicates the close relationship of the Acarina and the Solpugida.

This species is also probably well distributed over the State since it has been recorded from coast to coast and from Canada to the Gulf. Records are most numerous from the northern part of this range. It frequents damp situations beneath stones, boards, and other debris, and loose bark on standing trees.

Family Bdellidae

The striking character of this family is the long pointed chelicerae, apparently united along the median line, which projects from the cephalothorax as a true beak. This has suggested the common name of "snout mites." A further character that distinguishes them from the preceding family is their bright red color, altho an occasional specimen may be nearly black. The strongly elbowed, three- to five-jointed palpi, which usually terminate in long spines or hair-like bristles, are also characteristic. The palpi function as tactile organs in all but the genus *Cunaxa* where they serve to capture and hold prey. The abdomen and cephalothorax are easily distinguished. The legs are usually quite long and separated into two groups, except in the genus *Bdella* where they arise near together. Movement is quite rapid and may take place in several directions. The larvae are hexapod and the nymphs resemble the adults in color and general shape. Sexual dimorphism is not apparent. The family is well represented in arctic and temperate zones, but few species have been recorded from the tropics. All species are reported as likely to be predaceous upon other small arthropods.

Of the twenty some species in the genus *Bdella* the following are known from Ohio.

Bdella cardinalis Banks
Trans. Amer. Ent. Soc., XXI, 1894, p. 219

This bright red, active mite has been recorded from a number of localities in the State. It is quite large averaging about 1 mm in length. I have always taken it crawling about as tho in search of food. It seems equally at home in a dark crevice or in the path of brightest sunlight. Several were taken associated with a large number of Oribatid mites on the trunk of an elm tree. No feeding was observed in this instance. Another specimen was found soon after it had impaled a specimen of *Fessonia longilinealis* on its beak. The latter was still struggling when first noted. At the end of about ten minutes the body of *B. cardinalis* had swollen noticeably at the expense of *F. longilinealis* whose body soon showed clear spots and was finally left a mere shell by the fully engorged Bdellid.

During the fall months numerous adults and nymphs are to be found crawling about in woodlands both on the trees and on and among the fallen leaves and debris on the ground. Specimens taken in May are often small and have but six legs. Nymphs are

also quite common at this season. The species has a quite general distribution thruout the United States and Canada. It is often recorded as attacking various insects such as scales, nymphal Homoptera, Orthoptera and their eggs.

Bdella corticis Ewing
Can. Ent., XLI, 1909, p. 122

This species has the general form of the preceding but seldom measures more than .8 mm in length and is much less common. One specimen was taken at Chillicothe from a mass of debris in a chicken nest which was heavily infested with *Dermanyssus gallinae*. No feeding was observed. There are but few records of this species and it is apparently quite rare.

Bdella peregrina Banks
Trans. Amer. Ent. Soc., XXI, 1894, p. 219

This is a very large species averaging 1.5 mm in length. Like the others it is red in color and quite active. I have but one specimen, taken in leaf mold at Yellow Springs, September 22. The species, according to Banks, is quite common on damp soil in the east, but it seems to be rare in Ohio and westward.

Bdella tenuirostris Ewing
Bul. Amer. Mus. Nat. Hist., XXXVII, 1917, p. 149

The only material thus far recorded is the one specimen upon which the description is based, caught at Xenia, Ohio, September 14, 1910.

Scirus, the other genus of this family recorded from Ohio, is represented by a single species. This genus is close to the true *Bdella* but includes those species which have the last palpal joint long and cylindrical.

Scirus quadripilis Banks
Trans. Amer. Ent. Soc., XXI, 1894, p. 220

These mites are also red but average only .7 mm in length. One specimen was taken July 21 from the lower side of a leaf of *Nyssa sylvatica* in woods near Chillicothe. There was no malformation on the leaves and the mite had probably wandered into this position in search of food. Another specimen was taken September 24 from beneath a slab of loose bark covering a termite's nest in the woods on Mt. Logan, near Chillicothe. Brain records the

species from Cedar Point on a board at the edge of the Black Channel. It would appear that the species is not often taken by collectors, since the type material from Sea Cliff, N. Y. is the only other recorded capture.

Representatives of the other genera in this family will very likely be reported from the State in later studies.

Section DACTYLOGNATHA

The members of this section differ from those of the preceding in that the last segment of the palpus usually forms a distinct thumb to the penultimate segment which ends in a claw. All the families thus far recorded from the United States fall in the superfamily Trombidoidea which includes the "red spiders," "harvest mites," etc.

Family **Cheyletidae**

This family has been placed among the Sarcoptidae as frequently as here but at present it is thot to be most nearly allied to the Trombidiidae. It is characterized by having the last segment of the stout, three- to five-jointed palpus provided with a short, movable papilla, near the inner side of the tip of which there may be large claws or pectinate setae. The penultimate segment is armed with a very large, stout claw. This appendage is possessed of a horizontal motion. The papilla is thot to be homologous to the thumb of the Trombidiidae. A striking character of typical Cheyletids is this pair of enormously developed palpi attached to a distinct beak. It is the most specialized palpal modification for seizing and holding prey of any found in the Acarina. The beak is distinctly separated from the body by a constriction but the cephalothorax and abdomen are not distinct. The long needle-like mandibles possessed by most of the forms are adapted for piercing. There are a few scale-like hairs on the body. The short, five-jointed legs end in two claws with a pecten between them. The front legs in some are developed into organs for clasping prey, while in others they appear to have a tactile function. Movement is rather slow in all the species.

Most of the forms are minute and of little-known habits. Some are free, living upon scale insects and the eggs of various insects; many are known only from a large number of different birds where they feed upon parasitic lice and mites. Several forms, *Picobia, Cheyletoides,* etc., live for a time within the quills of various birds' feathers where they feed upon some of the other

mite residents found there. The predaceous forms can be considered as distinctly beneficial and several, among them *Cheyletus pyriformis* Banks, rank as natural factors of considerable importance in holding down the numbers of scale insects. Several records are also before me indicating the value of *Cheyletus audax* Banks and *C. seminovorus* Packard in destroying various *Tyroglyphids* infesting stored grain. A few genera are parasitic, *Psorergates* and *Harpyrynchus* on birds and *Myobia* upon rodents.

The eggs are deposited either singly or in small clusters and in some species a few silken threads are spun to hold them in place. A few cases are recorded of the female guarding the eggs for some time after laying them. Except for its six legs the larva resembles the parent quite closely. The male is the smaller of the sexes.

But one species is thus far known to Ohio, altho a number are recorded from North America.

Cheyletus seminivorus Packard
Guide Study Insects, 1869, p. 665

I have but few specimens from Ohio and these were taken during late September. One was taken in loose soil along the Little Miami River near Yellow Springs, Ohio. Others were captured under loose bark lying on the ground in the woods on Mt. Logan. All were pale yellow in color and moved slowly. No feeding was observed. Altho this species is undoubtedly quite common thruout the United States, it is but infrequently recorded. Dr. Ewing in the Jour. Ec. Ent. V, 5, 1912, pp. 416-420 presents a discussion of its biology.

Family Erythracaridae

This family name replaces the older one of Anystidae. It is very poor in species but one of these is unusually common and at the same time beneficial. The most striking characters of the group are the contiguous radial arrangement of the coxae near the anterior end; the absence of processes on legs I and II; and the lack of shields on the integument. The demarkation between cephalothorax and abdomen is quite indistinct. The body is provided with many stout bristles. The eyes are simple and occur in one or two pairs. The mandibles are large, tapering to a point terminated by a curved claw, and are very powerful. The palpi are prominent, but slender and, except in the genus *Anystis*, have a thumb. The six-or seven-jointed legs are long, strong, and usually end in two or

three claws. The larvae resemble the adults but are hexapod. But one representative of the family has thus far been taken in Ohio.

Anystis agilis Banks
Trans. Amer. Ent. Soc., XXI, 1894, p. 211

This species was long known as *Actinidea agilis*. A large number of specimens have been taken from so many localities that it can be considered as generally distributed in the State. From May to late September I have taken this mite in various habitats. Larval and nymphal forms predominate during the early season and adults are most common from early August until cold weather. I have taken a few adults in the spring which would seem to indicate that this stage may hibernate. Specimens have been taken on the ground and on plants in meadows, cultivated fields planted to various crops, and in waste lands and woodlands. I have never observed feeding. The mites are roundly triangular in shape, of a pale to bright red color, and, because of the long legs, are capable of rapid movement in an erratic manner. Adults average .9 mm long by .7 mm broad. The species occurs generally thruout the United States, southern Canada, Northern Mexico, and the Bermuda Islands. It is entirely predaceous in habit and is recorded as attacking various species of aphids, small caterpillars, saw-fly larvae, and small beetles. According to Banks "The young before transformation spins a white silken web on a leaf or in a crevice of bark and beneath it changes to the adult form."

Species in the genera *Geckobia* and *Pterygosoma* have been taken as parasites on various lizards in the old and new world.

Another family, Caeculidae, has thus far no known representatives within the State. It is similar to the preceding family but has several dorsal shields on the body, and legs I and II have spine-bearing processes. Banks records several species from this country.

Three families of the Trombidoidea—the Trombidiidae, the Erythraeidae, and the Tetranychidae—have the coxae arranged in two groups and are thus at once distinguished from the other two families. All have representatives in Ohio.

Family **Tetranychidae**

The "brown", or "clover mites," and the more numerous "red spiders" as well as other small plant-feeding forms are included in this family. In all, the palpi show the claw and thumb arrangement but they are very minute and easily overlooked. The man-

dibles have their basal joints united to form a plate, while the terminal joint is long and needle-like and is called a "stylet." With this organ the mites pierce the host tissue and withdraw the cell contents. The legs are moderately slender and bear scattered hairs. The tarsi are never swollen and terminate in one or two claws. Spinning glands are present in most species. Of the numerous genera in this family only a few are thot to be predaceous and concerning these there is considerable doubt. Banks suggests such a habit for *Syncaligus* and *Raphignathus*.

The definitely known plant feeding habits of the other genera immediately suggest the possibility of injury to crop plants. For some species of wide distribution and enormous reproductive capacity the total injury for the world amounts to an appalling figure. Five genera of the family Tetranychidae have thus far been taken in Ohio.

Banks considers the genus *Syncaligus* synonymous with *Acheles,* but I can see no reason for so considering it and shall employ the former. This genus includes minute reddish mites in which the legs are normally proportioned; the dorsum is not divided into small areas; the abdomen is not sutured to suggest segmentation; the short stout palpi show well the claw and thumb arrangement; and the supramandibular plate is wanting. Dr. Ewing has described several from the leaves of oak and apple in the West. The latter is quite injurious. But two species are known from Ohio.

Syncaligus cardinalis Ewing
Trans. Amer. Ent. Soc., XXXV, 1909, p. 403

This is a small bright red species which was taken by Dr. Ewing beneath lichens on *Acer saccharum* at Xenia, Ohio, September 14, 1910.

Syncaligus conspicuous Berlese
Acari Nuovi, Redia VI. Manv, 1910, p. 203

This is also a small bright red species measuring about .5 mm in length by .25 mm in width. The legs are short, making movement very slow. The only specimen taken was found September 24, 1923 in a mass of decayed walnut bark lying on the ground near Chillicothe. According to Banks the type material came from this country, but it is recorded but twice and seems to be rare.

The genus *Bryobia* is readily separated from the others in this family by having four prominent tubercles on the anterior margin of the cephalothorax and an unusually long pair of front legs. I have but one species from Ohio.

Bryobia praetiosa Koch
Ubersicht der Arachniden system, 1837

It was long thot that the common clover mite of this country was distinct from the one occurring in Europe and until recently ours was known as *B. pratensis* Garman. Dr. A. C. Oudemans has compared material from both sides of the Atlantic and states that there is but one species involved. However, Dr. Ewing has described what he believes to be two distinct species from this country. One is found in Arizona and the other in Nebraska.

This mite is recorded from all parts of the State under varying conditions. The spherical, deep red eggs have been taken in large numbers from apple, plum, and maple trees, where they occur beneath the loose bark and in crevices on branches and twigs. They have also been taken on such plants as clover, both white and red, blue grass, peas, beans, etc. where the adults often feed during the summer. Eggs deposited in the fall upon trees remain virile thru the winter and hatch early in the spring. The young larvae begin at once to feed upon the nearest vegetation, which may be the tender leaves and blossoms of fruit trees. Here they may effect considerable injury and it is frequently found necessary to make some sulphur application to check their ravages. A winter or dormant application of Scalecide used at the rate of 1 to 15 parts of water will effectually destroy the eggs. A mixture of 1 gallon of commercial lime-sulphur, 2 gallons of flour paste, and 50 gallons of water is an effective spray for the mites. The paste is added after the lime-sulphur has been diluted.

The larvae do not have the fore legs greatly elongated and measure about .25 mm long by .2 mm wide. They are red in color. The nymphs resemble the adults in all but size and color, the former usually being of a greenish hue and smaller.

The adults measure about .8 mm long by .6 mm broad. The body is dark reddish brown while the legs are usually paler. Food contents in the body may vary the color to almost black. The integument is finely striated. There are at least three generations in Ohio and when the fall season is favorable there may be a fourth.

A habit peculiar to the species is that of entering buildings during the fall. The exact prompting of this migration is still to be determined altho heat probably plays a major role. Nymphs and adults will swarm into houses, spend the entire winter there and in the spring pass to the outside. I have observed this on several occasions. There was no food supply in the form of green plants available yet thousands of the mites remained alive thruout

the winter of 1923 in a cold basement room. During a period of about two hours during the morning the sun shone upon the only window in this room. The mites would then crawl from hiding in the cracks of the window casing and swarm over the warmed glass. As the sun passed off the window pane the mites would crowd into the ever decreasing heated area and when the glass became cold they would again hide themselves in the cracks. This increased activity in sunlight is characteristic of the mites when wintering in houses. I was unsuccessful in rearing any of the mites on potted clover plants during the winter. No oviposition was noted during the winter. A large number escaped to an adjoining lawn in the spring where they or their progeny remained numerous thruout the summer and reinfested the same room the following winter.

This entering of houses by *B. praetiosa* has, during the past 75 years, caused considerable concern on the part of housewives and others thruout this country. Since the young and adults feed exclusively upon vegetation, it seems that the swarming into houses can be anticipated by observing turfs and other vegetation near the house and thoroly dusting the infested areas with flowers of sulphur which will kill the active stages of the pest and not injure the foliage. Fifty pounds of the dust to the acre is sufficient to destroy the mites. Pastures may also be treated in this manner when the mites become troublesome. Once the mites gain access to a house persistent cleaning and application of benzine or gasoline directly on the mites are the best control measures.

The species may be considered as cosmopolitan in distribution. It is known to feed upon peach, almond, and *Arum maculatum* in Australia; on asparagus, etc. in Germany; Salix sp. in Alaska; fruit, nut, and ornamental trees in South Africa; and a host of common annual and perennial plants in North America.

F. M. Webster, U. S. Dept. Agr. Bur. of Ent. Cir. 158, gives the larvae of *Tineola biselluella* Hubn. as predaceous upon the eggs, and suggests that various lady-bird beetles and their larvae and lace-winged flies may also prey upon the mites and eggs.

The genus *Tenuipalpus* has short palpi which do not show the thumb arrangement distinctly altho they taper and terminate in a sharply recurved claw. The second joint of the transversely wrinkled legs is very short, thus giving the claws a pedunculated appearance. The terminal leg segment carries six hair-like caroncles and two weakly-curved strongly-tapering claws.

Tenuipalpus lineola Canestrini and Fanzaggio

Several specimens were taken from leaves of *Sambucus canadensis* near Chillicothe, September 24, 1923. The mites resemble the typical species very much. They are nearly hyaline except for a slight green or red hue given by partly assimilated food. The species is recorded from the same host in Connecticut by Garman, and from various southern states on *Rumex* sp., *Oxalis* sp., garden mint, and privet by McGregor. Here it often seriously injures the privet. From this range of hosts and its injurious nature on privet it may be considered as a potential pest. However, reproduction is slow and except under most favorable conditions no injury need be feared.

The genus *Tetranychus* was long used to include all the so-called "red spiders." As more careful morphological investigation was undertaken there appeared characters which were considered of sufficient value to justify the splitting of the genus into some six or more genera. All of these subdivisions have not been recognized as of generic rank by all workers, and since the question is far from settled a discussion of these new genera will be omitted.

In 1910 F. Zacher established the genus *Paratetranychus* for two European mites possessing a complex claw with from four to eight spurs which are appendiculated at the base or between it and a mid-point of the claw. The dorsal spur is most prominent and as long as or longer than the appendiculated spurs. The collar tracheae are straight and terminate in a bladder-like chamber. These structures were first noted by Tragardh in 1915 and have been found to be fairly constant for generic differentiation. They run closely beneath the cuticle in a fold of the proterosoma, diverging from a point below its margin and extending outwards and backwards. The type, *Paratetranychus ununguis* Jacobi, was designated in 1915 by Tragardh. The genus now includes several other species some of which occur in this country. The specific synonomy, on account of the generic separations, is quite confused.

Past workers, and even some of our present ones, because of lack of access to all earlier descriptions of new species, some of the earlier of which are undoubtedly inaccurate as species are now considered, have redescribed many old species. Differences in host, locality, etc, have served to separate species. C. V. Riley early described a mite predaceous on scale insects of citrus trees as *Penthalodes mytilaspidis*. Later workers found a Tetranychid very numerous on citrus trees and construed Riley's description as

applying to it and therefore it was rechristened *Tetranychus mytilaspidis*. This name was generally adopted without question. Later it was learned that *P. mytilaspidis* Riley was distinct and a good species, so *T. mytilaspidis*, by this time commonly called the citrus mite, was left without a name. E. A. McGregor then proposed the name *T. citri* for the mite on citrus trees and gave a new description for it. Further investigation revealed that *T. citri* McG. was no other than *Paratetranychus pilosus* Can. and Fan. of Europe. This brief outline of the naming and renaming of material will indicate the care that should be taken in establishing new species. Many species now considered to be distinct will be found by future workers identical with others already well known.

Paratetranychus pilosus Canestrini and Fanzaggio
Intorno agli Acari Italiani, Atti Ist. Venet. ser. 5, IV, 1877-78, pp. 69-208

This species is commonly known as the European red mite or the plum spider mite. Various stages of this mite were taken thruout the year at different places in Ohio and its distribution was quite general. The occurrences were most frequent upon apple where severe injury resulted in several localities. Other hosts from Ohio are plum, pine, and mountain ash.

The appendiculate claw is six-cleft and together with the other generic characters will separate it from the other species. The egg is flattened spherical in shape and .15 mm in diameter. From a pale pink color when first laid it assumes a dull red as the contained embryo develops. This latter color is also that of the overwintering eggs. A peculiar hair-like process surmounts the egg. No superficial difference exists between the summer eggs on the foliage and those on the twigs and branches in which state the species survives the winter.

The overwintering eggs, which are laid during September and early October, hatch when the fruit buds begin to show pink. During the summer season, 20 days is usually required for development from egg to maturity. As much as 30 or more days may be required for the same transformation in spring or fall. The females deposit about three dozen eggs, beginning about three days after reaching the mature stage. They live from two to three weeks. The young resemble the adult in shape, but are paler in color and smaller and have only three pairs of legs. Males are usually smaller than the females. Both sexes are red to brown in color, varying with the host plant. Like most mites they spin a

fine silken web over the part of the plant upon which they are living, which is sometimes the trunk. Dr. Ewing believes that this silk serves to give the molting mites a surface easily held to, while other authors feel that it serves as a support for the eggs. In my studies it was seen to serve in both these capacities.

The species is recorded from a number of localities in Europe, Asia, and North America, and from a wide range of fruit, shade, and forest trees and shrubs. The date of its first appearance in this country is uncertain but it has been recorded from nearly every state in the union during the last thirty years. Its attack usually causes the leaves to become a rusty brown to yellow color which may result later in death. In cases of severe infestation, premature defoliation occurs resulting in small or otherwise malformed fruit.

A number of natural enemies have been recorded as serving to hold this mite in check. Certain species of thrips, ladybird beetles and their larvae, small Heteroptera and Neuroptera, and predaceous mites are included among those attacking the eggs and active forms. These enemies appear to become most numerous during July and August, which is also the time of greatest abundance of the mites. A summer when showers are frequent is most unfavorable for increase of all red spiders. Various winter changes in weather affect the eggs to a noticeable extent.

That a definite spray schedule should be followed in orchards is of course recognized and, where red spider of any species is present, a special spray will be found necessary. Either Scalecide or any one of the engine oil emulsions on the market, when used at the rate of 1 to 15 parts of water and applied when the temperature is not below freezing, will serve to kill the eggs. These are dormant sprays. For the control of the active forms during the summer, the infested plants should be thoroly sprayed with lime-sulphur diluted to 1-50. A spreader will increase the effectiveness of summer sprays. Flour paste as recommended for the clover mite will serve, or certain casein spreaders may be used. Spraying should not be done when the temperature is above 90 degrees F. For thin-leaved varieties the dilution should be at the rate of 1 part of lime-sulphur to 75 parts of water. Where the mites are abundant at least two sprays incorporating lime-sulphur should be used following the pink spray.

Paratetranychus ilicis McGregor
Proc. U. S. Nat. Mus. LI, 2167, 1917, p. 587

This species bears an almost exact resemblance to *P. pilosus* with the exception that the appendiculated claw is only five-cleft. Should it be that the divisions of the claw are variable, then *P. ilicis* McG. will become a synonym of *P. pilosus* Can. and Fan. I have had but a limited amount of material to examine and am not able to determine the matter of claw divisions. The host of the type material was *Ilex opaca* in South Carolina.

Several specimens were taken from both the upper and lower sides of the leaves of *Cornus florida* on Mt. Logan, July 18, 1923. A fine silken web covered the leaves. The majority of the active forms were on the upper surface while the eggs were most numerous in the vein angles on the lower side. The eggs and larvae are milky white in color while the adults are dark brown blotched with white. But this one record from Ohio and a few scattered ones from the United States indicate that the species is not a common one.

Paratetranychus yothersi McGregor
Ann. Ent. Soc. Amer. VII, 4, 1914, p. 355

Mites corresponding in all details to this species have been taken on *Quercus palustrus, Ulmus americana, Acer saccharum* about Chillicothe and on *Castanea dentata* in a forest near Loudonville. All trees attacked by this species were heavily infested and could be detected at some distance because of the sickly yellow color of the leaves. Premature defoliation was in process.

A fine web was spun over both sides of the leaf and beneath and on this numerous eggs and active mites in various stages were present from early May until late August. Increase was phenomenal during August. The eggs and young mites were usually congregated in large numbers in the vein angles of the lower side. Adults were mostly hyaline tinged with green, and showed large darkened areas where food particles occurred in the alimentary tract. The dorsal setae in mature forms are not situated on raised tubercles.

No records were found for this species in any of our northern states; but McGregor gives it a wide distribution thruout our southeastern states, with its host plants as white oak, elm, willow, camphor, avocado, mango, eucalyptus, and several other trees. The attack on the avocado is often of serious proportions. The predators cited for *P. pilosus* are also instrumental in decreasing

the numbers of this species. A dust of superfine flowers of sulphur or a lime-sulphur spray 1 to 75 parts of water gave as high as 99 percent control. The species may be considered as a potential pest of fruit trees in northern states.

But one other genus in this family is known from Ohio. The genus *Tetranychus* Dufour, as suggested before, had long been used to include all the red spiders. With the splitting of the genus, *Tetranychus* was retained for those species in which the single sharply-curved empodial claw was cleft to the middle into five or six subequal divisions. The collar tracheae are V-shaped and of fairly uniform diameter thruout their length.

Here again many species have been erected on the basis of color and host, but Dr. Ewing and others have proved this character to have no specific value. The characters of the male copulative organ are now used as the basis of specific determination by some workers. It appears to be less variable than many bases used in the past, but is often difficult to study because of its retractile nature.

The body is generally sub-pyriform and bears dorsally four rows of from six to nine bristles each. The species all spin a web. The silk glands are situated in the anterior portion of the cephalothorax and open near the base of the mandibles, the palpi aiding in the manipulation of the thread as it is emitted.

Tetranychus telarius Linnaeus
Fauna Suecica, 1761, 1974, p. 431

This species was first described as *Acarus telarius* by Linnaeus in the above citation. Dufour in erecting the genus *Tetranychus* redescribed it as *T. lintearius*. Since then it has been described in 4 genera and in no less than 28 species. Most of these were merely color variations.

It has been recorded from many places in Ohio at all seasons of the year. It is the most common of the red spiders found in greenhouses where it may frequently do severe injury to nearly all species of plants. In the field it attacks practically all of our fruit, forest, and shade trees and shrubs as well as the majority of the truck and field crops and flowers. The host list includes upward of 250 species and is too extensive to include here.

Dr. Ewing has given an excellent treatment of the species in Oregon Experiment Station Bul. 121, 1914. The egg laying capacity of the females varies from 8 to 94. Climatic and food factors

influence the variation. The rate of deposition is also quite variable, ranging from a few to many within a short time depending largely on the temperature. The incubation period varies from 3 to 8 days. A larval and two nymphal stages occupy about 10 days, after which the adult appears. The adults remain active from 3 to 4 weeks. Adults and second instar nymphs pass the winter successfully beneath debris and in loose dry soil. They seldom winter in bark crevices. During the mild days of winter the mites may become active, often feed, and, if the mild weather continues for several days, they may oviposit. Overwintering mites appear early in the spring but rapid development is retarded until drier summer weather. Parthenogenesis has been shown to exist in this as well as in other species of the genus. There are 9 generations at Corvallis, Oregon and 16 or more at Batesburg, South Carolina. The annual loss from the attack of this species on all crops amounts to an enormous figure.

An extended survey of greenhouses in all parts of Ohio has shown this species present in all. Many different methods are employed to check its ravages but the loss in greenhouses alone amounts to millions of dollars. Chrysanthemums, roses, sweet peas, violets, carnations, calla lilies, geraniums, *Budlium* sp., etc., are the most severely attacked, probably because they are the most often grown. Cucumbers, tomatoes, egg plants, etc., when grown under glass, are also severely injured. In all cases feeding is accomplished by inserting the needle-like stylets into the plant and withdrawing the cell sap and leaving the foliage a sickly green to almost yellow color, often followed by the death of the plant if the attack is not checked. The fine web which covers the plants protects the mites from many applications designed to kill them.

Because of the greater succulence of most plants grown under glass it is seldom practical to apply the same remedial measures in the greenhouse that are used in the field. From the fact that red spider development is most rapid under hot dry conditions it would seem that a high humidity would soon check their ravages. The usual and most effective practice in greenhouses is to thoroly syringe the plants with water under at least 25 pounds pressure. A specially designed nozzle should be used, or application be made so as to allow the surplus water to run off onto the walks. Even a moist air will greatly reduce the injury from red spider by killing the mites. By application of the water the mites are knocked from the plants and usually lost in the wet soil of the plant bed. It should be repeated at two or three day intervals. For a few potted

plants in a residence dipping them in a solution of one pound of soap in four gallons of water every four to seven days will soon rid them of the mites. Where the nature of the plants will not permit frequent syringing a dust of superfine sulphur has been found to greatly lessen their numbers.

For control of red spider in the field several procedures, depending on the plants to be treated, can be followed. A severe outbreak of red spider is most likely to accompany a dry season and by knowing the conditions of the preceding year as to the abundance of the mites one may anticipate an outbreak in advance. On the occasion of several outbreaks of red spider on plum and apple in southern Ohio the general program and materials recommended by E. R. DeOng in California Station Bul. 347 was suggested. Excellent results were reported by the growers concerned. The spray consists of 5 lbs. of flowers of sulphur made into a paste with 1½ gal. of hot water in which ¾ oz. of powdered glue has been dissolved and this diluted to make 100 gal. The first application would normally come during the last week of June or the first in July. It is usually sufficient since the mites are not as yet numerous. If one has delayed until the outbreak is severe it will be necessary to make two and possibly three applications at three week intervals, adding 1 gal. of commercial lime-sulphur to each 100 gal. of the above mixture. Dusting is seldom practiced to advantage under orchard conditions.

For truck crops the above spray less the lime-sulphur concentrate is very effective. Dusting is coming into quite general use for combatting truck crop insects. Flowers of sulphur applied as a dust either alone or incorporated in another dust at the rate of 30 lbs. to the acre is quite effective in controlling mites. One application if properly timed is sufficient to remove the menace, but delay may require the application of the material at bi-weekly intervals. To make any spraying or dusting program effective it must be followed carefully and accurately.

Tetranychus telarius L. is one of several species of mites that is cosmopolitan in distribution, being recorded from all continents and many islands. Its hosts are numerous and varied. Distribution has been effected locally by crawling, drifting with flowing water, and by wind blowing the mites and their silken thread onto an adjoining plant. To account for the world-wide distribution we must trace shipments of nursery stock from country to country thruout the world.

Tetranychus multidigituli Ewing
Jour. Ec. Ent., X, 5, 1917, p. 497

But one record of this species, the type material from the bark of *Gleditsia tricanthos* at Wooster, Ohio, November, 1912, taken by Mr. J. S. Houser, is known for the State. The mites are about .5 mm long by .2 mm broad. Several setae at the tip of the thumb, the short body setae, and the broad truncate-tipped tarsi separate it from the other species. It is apparently a rare species.

A large number of the Trombidoidea are peculiar in having very large palpi; short legs with swollen tarsi; and a body usually red and thickly covered with numerous short setae. Variations in these characters easily separate the forms into several families.

Family **Erythraeidae**

The family name Rhyncholophidae was long applied to this group of mites. The chelicerae are styliform; the large cephalothorax is on a plane with the abdomen; the dorsal groove, or crista metopica, is usually present; and the eyes are sessile. The crista may be enlarged in one or several places. Its exact function is not definitely known. The five-jointed palpi are prominent and have a well developed claw and thumb. The seven-jointed legs are usually long and slender and terminate in two claws.

The general habits of the group are quite varied and have been but little studied. They can usually be found in mesophytic conditions, climbing about on plants or over the ground. The eggs are deposited beneath debris or in loose soil. The six-legged, orange-colored larvae are parasitic upon a number of insects such as aphids, flies, moths, butterflies, phalangids, etc. When engorged they drop from their host to the ground and become quiescent. Later in the season the adult appears. Some species winter in the egg stage.

A number of genera are included in this family. Representatives of these occur thruout all continents, altho none are now known to be cosmopolitan. Four genera are known from this country. A student of this group will find many unsolved questions of synonomy. Three genera and eight species are thus far known from Ohio.

The genus *Atomus* does not possess retractile mouthparts nor are the tarsi armed with plumes nor the legs provided with spines. No sexual differences are apparent. There is but a single pair of eyes. The genus was long known as *Rhyncholophus* and many of our species were described under this name.

Atomus parvipollicus Ewing
Trans. Acad. Nat. Sc. St. L., XVIII, 5, 1909, p. 61

These mites are bright red in color and the body is covered with finely barbed hairs. Mature specimens measure about 1 mm long. From early May to late September adults occur thruout southern Ohio. They have been found both on the plants and on the ground. Large numbers have been taken from the fresh silk of ears of corn. Eggs of *Heliothis obsoleta*, the corn ear-worm, were often numerous on these ears but no mites were ever observed feeding upon them.

On May 14, 1923 numerous specimens were taken with their stylets deeply inserted in the leaves of young cabbage plants. The mites were numerous in this particular patch. This would suggest a plant feeding habit and account for their presence on the tender corn silk. The anterior legs are kept constantly palpitating while the mite is crawling about and seem to probe the crevices in its path. The species is probably common thruout the State. Dr. Ewing reports the type material from Arcola, Illinois but other records are wanting.

Atomus longilinea Ewing
Bull. Amer. Mus. Nat. Hist. XXXVII, 1917, p. 155

I know of no records other than that of the type material collected by Dr. Ewing at Xenia, Ohio beneath bark of apple trees. It resembles Fessonia sp. Adults measure 2.5 mm long by 1.75 broad. It is not a common species.

Atomus quadrirubripes Ewing

This species has been taken but twice within the State, both times from Chillicothe, one on May 10 in an alfalfa field heavily infested with aphids, and the other July 24 in a field of cabbage badly infected with "yellows". Aphids were numerous in the latter case also. No feeding was observed, but since aphids are known to serve as hosts for the larvae in some cases it is not unlikely that such a relation could exist here. The species is not often recorded, altho it does not seem rare.

Atomus robustus Banks
Ann. N. Y. Acad. Sci. VIII, 1895, p. 432

This is a large species measuring about 3 mm in length. It is very common in southern Ohio during September. It has always been captured on the trunks of trees where the bright red mites are quite conspicuous. Movement is quite rapid.

Banks records the species as abundant about Fort Collins, Colorado, which would suggest a rather wide distribution in this country.

The genus *Erythraeus* is similar to the preceding genus but differs in having two pairs of eyes and the posterior pair of legs very long. The old genus Rhyncholophus, for some time, included the members of this genus.

Erythraeus parvisetosus Ewing
Trans. Acad. Sci. St. L., XVIII, 5, 1909, p. 57

This is an almost black species, adults of which measure 2 mm in length by 1.5 mm in width. On September 9, 1923, while collecting insects from cow dung near Chillicothe, I captured several specimens of this species in tunnels made in nearly dry cakes of this material. The abdomens were quite distended. One individual was standing over a mass of small shiny black eggs which she may have been depositing when disturbed. The material was collected in situ and placed in a battery jar. All individuals were later observed laying eggs similar to those already referred to. No adults lived beyond the middle of October. The eggs were placed in conditions that might prevail in the field and the following May nearly all hatched. All died altho I offered them aphids of several species and a number of beetles.

Dr. Ewing records the type material from Muncie, Illinois and states that the adults seem to carry the young upon their backs as parasites. If those adults I have observed did not suffer premature death such a relationship would scarcely be possible. But the two records mentioned seem to pertain to this species.

Erythraeus phalangiolus Ewing
Bul. Amer. Mus. Nat. Hist. XXXVII, 1917, p. 153

The species is peculiar because of its very long legs, whence its name. It was at first mistaken for an immature phalangid. Adults are 1.7 mm long by 1.4 mm broad. I presume it to be red since no color is given in the original description. The type material collected under elm bark at Xenia, Ohio is the only material known to me.

Erythraeus pilosus Banks
Trans. Amer. Ent. Soc., XXI, 1894, p. 217

This is a bright red species. It is common in southern Ohio from early June to late September, and is probably well distributed over the State. Slight depressions on the dorsum and the covering

of fine hairs reflect light as silvery streaks which seem to ripple across the body as the mite walks. Mature specimens are about 1.5 mm long, and quite active. I have observed no feeding.

Mr. T. D. Jarvis, in the 40th Ann. Rpt. Ent. Soc. of Ontario, 1909, pp. 82-109, records this species as predacious upon the eggs of an Ichneumon sp., on Cecropia moths, and on apple canker worms. I have records which indicate the occurrence of this mite thruout the north central states and southern Canada.

The genus *Fessonia* is peculiar in having highly retractile chelicerae which are often not visible when withdrawn into the body. These mites also possess five-jointed legs and two pairs of eyes. A third pair of eyes may sometimes be present on the anterior margin of the cephalothorax. But one species occurs in Ohio.

Fessonia longilinealis Ewing
Trans. Acad. Sci. St. L., XVIII, 5, 1909, pp. 61-62

The species was first described as *Smaris longilinealis* but is now placed in the present genus. It is bright red in color with the legs and mouthparts paler. Mature specimens are very active. They measure about 1.7 mm long by 1 mm broad. I have taken this species from early May until late September thruout southern Ohio. Nymphs are quite abundant early in the season. They occur on the ground in open woods and fields. No feeding has been observed. It is recorded from several of the north central and eastern states and is probably well distributed over this area.

From this presentation of the family Erythraeidae in Ohio one will notice how little is known about the specific habits of a group of mites that are parasitic as larvae and, at least in some cases, predaceous as adults.

Family **Trombidiidae**

The family Trombidiidae is separated from the preceding in having each of the chelicerae armed with a falcate or jaw-like appendage at its tip and in having a small cephalothorax on a different plane than the abdomen. The separation of the body is prominent and each bears two pairs of legs. All the species known are some shade of red. The body hairs are feathered. The palpi are five jointed and terminate in the claw and thumb. The seven jointed legs end in two claws. There are two eyes on each side of the cephalothorax which are usually stalked. The crista is usually quite prominent. In some species bristles arise from enlarged

areas in the crista. Some authors consider them as pseudostigmatic organs but they are scarcely homologous with the similar structures in the Oribatidae.

This group, popularly known as the "harvest mites," is known to most field observers. In the spring the bright red adults of some species appear in open fields and woods in large numbers. They crawl about in search of eggs or small arthropods upon which to feed.

The eggs are usually deposited in the spring in clusters in small cavities in the soil. The larvae upon hatching are orange red in color, have but six legs, and are quite minute. Those of some species are parasitic upon various insects while others attack the vertebrates. Many have a habit of temporarily fastening themselves to man where they are quite irritating. In oriental countries, several species with this habit transmit fatal diseases.

When engorged the larva drops from its host and usually finds shelter beneath debris or in loose soil. Here it passes into a quiescent stage after which it appears as a nymph possessing four pairs of legs and resembling the adult in all but sexual maturity. Following a brief period of feeding the nymph again transforms into a pupal phase from which the adult appears. The adults may not appear above ground until the following spring, passing the winter in their earthen cell. Parasitism is not recorded for any of the adult or nymphal stages. They are always observed in the role of predators upon some smaller arthropod or its eggs.

Here again the student will be confronted by a confusing synonomy. The genus *Trombidium* at one time contained all our species but this has been split into many new genera. Many species have been established on larval forms and little attempt has been made to link larva with adult. Representatives of the family are known from all parts of the world. Eight species in six genera are known from Ohio.

The genus *Allothrombium* has the crista expanded at the middle where it bears a pair of pseudostigmata. There is a conspicuous pulvillus between the tarsal claws. The eyes are truncate. The palpi bear but a single claw at their tip.

Allothrombium pulvinus Ewing
Bul. Amer. Mus. Nat. Hist., XXXVII, 1917, p. 157

This is a large dull scarlet species measuring about 4 mm long by 2.3 mm broad. This separates it from our other species. Mr. C. W. Howard has succeeded in working out the life history of the species.

The eggs are spherical and about .2 mm in diameter. They are deposited during May and June beneath leaves or in loose soil. They are usually deposited in clusters of 100 or 200, with a few silken threads spun about the mass. They hatch in from three to five days, until mid-July. The small, hexapod, scarlet larvae crawl about in search of a host. They often ascend plants or other objects in their path. Several species of aphids serve as satisfactory hosts. One can see how the negative geotropism displayed by the larvae will bring them most readily to an aphis colony. Several mites may attach to one host. They are not known to attack man. Upon engorgement the larva loosens its hold, drops to the ground and makes its way into loose soil for a short distance where it transforms to a nymphal stage. This process takes place during June or July and requires about one week. Nymphs, which greatly resemble the adults in all but size and sexual maturity, feed upon a variety of small insects occurring in their habitat. By early August they again begin to enter the soil, undergo another transformation, and in about two weeks appear as adults. The mature mites are active until frost when they again enter the soil not to appear until the following spring.

I have taken the species in large numbers in hemlock forests about Bainbridge, Ohio during late April and thruout May. Attempts at rearing were unsuccessful. It is recorded from nearly all the north central states.

Allothrombium missouriense Ewing
Trans. Acad. Sci. St. L., XVIII, 5, 1909, p. 63

This species is separated from the preceding in being but 1 mm long and .7 mm wide. It is bright red in color and is one of the most common Trombidians in southern Ohio. Captures of adults date from early June to late September. They have been taken in weeds and trees and other plants where aphids were often abundant. I have observed them feeding but once and then upon a small Heteropteron. No rearing work has been attempted, and to my knowledge detailed life history data are wanting. From observations made, these do not vary greatly from the preceding species.

The type material was collected and described at Columbia, Missouri and this description is the only other printed reference to my knowledge. It is probably well distributed thruout the north central states.

The genus *Eutrombidium* has a posterior dorsal plate on the abdomen; the pseudostigmatic organs are in the middle of the crista which extends to the base of the cephalothorax; the palpi are armed with two claws; and the body is constricted at the insertion of the posterior pairs of legs. But one species is known from Ohio.

Eutrombidium trigonum Hermann
Mem. Apt., 1804, p. 26

This mite has been described under various specific and generic names, probably the most common of which is *Trombidium locustarum* Riley. It is commonly known as the "locust mite" from its usual association with various grasshoppers.

Extended observations on this species have been made because of its larval parasitism on grasshoppers and the habit of the adult of feeding upon Acridid eggs.

The bright red adults, about 3 mm long by 2 mm broad, are common in plowed fields or waste lands during spring. Due to numerous setae on the body the light is reflected as silvery streaks as the mite moves about. Adults were taken from March to late August. A few of those that lived longest were kept in rearing cages containing nothing but damp soil. During years of heavy grasshopper infestation the species becomes very abundant. It has long been known that the adults feed mainly upon grasshopper eggs. They crawl about on the surface and thru the soil crevices searching for eggs. When an egg pod is found they pierce the shell with their sharp chelicerae and withdraw the contents after which the empty shell collapses. Three or four eggs usually suffice to engorge an adult mite. I have records of this species feeding upon the eggs of *Melanoplus bivittatus, M. femur-rubrum, M. differentialis, M. atlanis, M. minor,* and *Stenobothris curtipennis.*

The spherical orange-colored eggs are deposited in clusters of several hundred in small cavities in the soil. The minute, six-legged, orange-colored larvae do not appear until nearly a month following oviposition. About two weeks previous to hatching, the outer egg shell splits and the legs of the embryo project as a nearly hyaline cone still contained within the inner shell. This is called the deutovium stage. Upon hatching the larva crawls about until finding a grasshopper, either nymph or adult. It attaches itself beneath the wing pads or wings, to the wing veins, at the intersegmental commissures, or most any thinly chitinized region of the body. I have found large numbers attached about the mouthparts but have never had them successfully engorge here. They also

exhibit a negative geotropism climbing to the tops of grass stalks, etc. Apparently adults do not oviposit until they have fed and since this is often a delayed process, especially where grasshopper eggs are scarce, eggs may be deposited as late as early September. From these eggs larvae may appear during October, but these seldom survive the winter.

I have fed the larvae upon nymphs and adults of *M. femur-rubrum, Chortophaga viridifasciata,* and *Dissosteira carolina;* while others record them from *Tettix sp., M. femur-rubrum, M. gladstoni, M. bivittatus, Stenobothris curtipennis, Orphulella speciosa,* and *O. palidna.* A few to nearly 100 have been found attached to a single host; but in such cases very few mature, or possibly all die, due to the death of the host. They engorge in from 1 to 3 weeks on a suitable host and when replete appear tick-like in form, whence another common name, "The grasshopper tick." Where engorgement has not begun, the larvae may be cast with the skin of a molting nymph, after which they may reattach to the same or another host. However, if the larva is in any stage of engorgement it is not able to detach itself and dies during the molting process. Where numerous larvae have engorged on a grasshopper nymph, the latter may be so weakened that it cannot molt successfully.

The majority of the larvae under observation reached complete engorgement and dropped from their host during July; but larvae in all stages of development can be taken until cold weather kills their host or forces them to hibernate. They make their way by worm-like movements into loose soil or under debris where transformation into the nymphal stage requires about a week.

The nymph resembles the adult in all but size and sexual maturity. They too feed upon grasshopper eggs and small arthropods or their eggs. After feeding from 2 to 3 weeks they again enter a quiescent stage from which the adult appears in from 1 to 2 weeks. I have never found the adults appearing from their earthen cell in the fall, altho other workers have and also have observed feeding during this season.

Both nymphs and adults can destroy an enormous number of eggs and in this way appreciably check an outbreak of grasshoppers. Altho the larvae seldom kill their host they undoubtedly retard its normal development to no small degree. This is one of the most beneficial of the Acarina.

I have liberated numbers of the larvae upon my body at various times but have never had them attach or become irritating, as has been the experience of other workers.

From records available this species is generally distributed thruout southern Canada and all of the United States, with grasshoppers and their eggs serving as the usual hosts.

The genus *Microtrombidium* is similar to the preceding genus, but lacks the dorsal shield on the abdomen and the pseudostigmatic area at the end of the crista. But one species is thus far known from Ohio.

Microtrombidium magnitarsa Ewing
Univ. Ill, Bul., VII, 1909, p. 92

This is a small species averaging about 1.5 mm long and 1 mm broad. It is bright red in color. Little is known concerning its habits.

I have taken adults during May and September beneath fallen logs and leaves in woods thruout southern Ohio. Feeding has never been observed. It is also reported from Iowa, Illinois, and Minnesota in similar habitats.

The genus *Sericothrombium* has the palpi armed with a single claw; the crista bears a pseudostigmatic area at the anterior end; and the tarsi are without pulvilli. The body is red and thickly covered with setae, which do not reflect the light as in *E. trigonum.*

Sericothrombium scabrum Say
Jour. Acad. Nat. Sci. Phila., XI, pt. 1, 1821, p. 61

This bright red, robust species measures about 3 mm long by 2 mm broad. Specimens may be nearly twice this size. The body is usually strongly constricted near the middle. The species is very common thruout Ohio, the adults appearing in large numbers in cultivated fields from April to June. The general habits are similar to those of *E. trigonum.* F. L. Washburn, Jour. Ec. Ent. 1907, p. 15, records them as active in sucking the eggs of the cabbage maggot, *Phorbia brassicae* Bouche.

Howard records the eggs as spherical lemon yellow objects deposited in masses of 200 or more in loose soil or beneath debris. The larvae appear in about 3 weeks. They engorge on small insects but the specific host is not known. They attacked a white rat, burrowing into the skin and causing lesions, but refused to attack a young pigeon. From our knowledge of the habits of Trombicula larvae, their burrowing into the skin appears doubtful. Successful rearing to maturity has not yet been achieved. The species is recorded from several of the north central states and will probably be found generally distributed over central and eastern North America.

The genus *Trombicula* also has the crista present and enlarged at the posterior end and the body strongly constricted at the insertion of the posterior group of legs. It includes about ten species none of which are cosmopolitan but all of which appear to have similar habits. To this genus belongs that group of mites commonly known as "chiggers" or "red bugs". The term "chigger" is used to designate most any itching sensation to which man may fall the victim; however I use it here as applying only to the larvae of this genus of mites. In tropical countries the larvae seem to occur in countless numbers, but I would judge that such infestations are relatively local. In Japan, where the common name of "kedani" is applied to *Trombicula coarctata* Berlese and to several other species peculiar to the country, these mites are the active agents in the transmission of a deadly human disease known as "flood fever". The normal host is the field mouse. In other areas of infestation the only apparent symptoms are a more or less severe itching sensation, which, thru scratching by the victim, may result in various complications that seldom prove fatal.

In the United States most investigators are acquainted with Riley's figures and descriptions of *Leptus irritans* and *L. americanus*. Recent workers, have attempted to show that the true chigger is neither of these long suspected forms but a species described by the English entomologist Murray.

Trombicula tlalzahuatl Murray
Ec. Ent. Aptera, 1877, p. 113

Dr. Ewing and Dr. A. C. Oudemans have done much to clear up many of the questions concerning this species. The latter has figured and described the larva in Zool. Jahrb., Sup. 14, pp. 18-24, fig. D. The mature specimens resemble *Trombicula cinnabaris* Ewing in nearly every detail.

The method of larval attack has long been a mooted question. Most observers and those suffering from attack hold that the larva actually bores into the skin. I have subjected myself to the attack of many larvae and have yet to find any part other than the mouthparts imbedded. Others have had this same experience. In humans with unusually large pores in the skin the chigger may actually imbed itself, but under normal circumstances this could not occur since the mites average three times the width of the largest skin pore. To present explanations for or against the numerous instances of chigger attack is not within the scope of this paper. No cases of successful engorgement of chiggers on man are on record from this country.

Under field conditions the larvae may be controlled by applications of flowers of sulphur in dust or spray form at the rate of 50 pounds per acre. This does not injure the sod. Since larvae and adults frequent fence rows it is wise to keep these clean. Should it be necessary to visit a region of known chigger infestation, one will find much relief from attack if he first dusts himself with equal parts of talcum powder and flowers of sulphur. The material causes no bodily irritation. Once a chigger has attached itself to the skin, sulphur ointment, alcohol, kerosene, salt-water, or a heavy soap solution will cause it to loose its hold. For palliatives ammonia, dilute iodine solution, camphor, baking soda, or xylene have been used with success.

Dr. Ewing has recorded this species in its larval form from several hosts including man, the rabbit, and king snake, *Lampropeltis getulus getulus*. There are numerous records of chiggers on poultry, quail, and various other ground nesting birds. Specific determination is wanting in most of these latter instances. During the season of 1924 large and small specimens of the black snake *Coluber constrictor*, the garter snake *Thamnophis sirtalis*, the common hog-nosed snake *Heterodon contortrix*, the black variety of the hog-nosed snake, and the eastern ring-neck snake *Diadophis punctatus* were captured carrying many chiggers. The hosts were taken thruout southern Ohio. The infested snakes were confined in suitable aquaria and fed. When molting the snake casts its parasites as well as its skin. When once attached and feeding, the mites are unable to loose their hold and die. Engorgement requires several weeks and the mites retain their hold long after they seem to have reached this condition. Difficulty in extricating the mouthparts may explain this fact. During September and possibly earlier the engorged larvae drop from their host and make their way beneath debris and into loose soil to a depth of an inch or more. The mite enters a quiescent stage and at the end of about three weeks appears in the adult stage. A nymphal stage may intervene but this was not observed. Adults do not appear above ground until the following spring, altho this may also vary in the case of earlier maturing individuals.

Trombicula tlalzahuatl is well distributed over eastern North America. It is common in most parts of Ohio.

The genus *Trombidium* has the crista enlarged at the anterior end; the palpi armed with but a single claw; and the tarsal claws without pulvilli.

Trombidium giganteum Riley
First Rpt. U. S. Ent. Comm. 1878, p. 312

This is a large, uniformly red species, measuring about 4 mm or more in length. The palpal claw bears a tooth on its ventral surface. It is usually thought of as being a subtropical species. However Riley records it from Salineville, Ohio and it was taken by Mrs. Slosson in New Hampshire. Little is known of its habits.

Trombidium muscarum Riley
First Rpt. U. S. Ent. Comm. 1878, p. 305

This smaller species measures about 1 mm in length. It is bright red in color. Its habits are imperfectly known. Riley and Ewing record the adults from beneath logs and debris. The bright red larvae are those usually found upon flies, whence the specific name. I have taken them from *Musca domestica* and *Chrysomyia macellaria* in southern Ohio. They were attached to the dorsum and venter of the body at the union of the segments. Here their chelicerae could pierce the thin membranes. I have also taken larvae attached to the squamae and at the joints of the legs. When the parasites are numerous the host is much hindered in flight. The species is common thruout the eastern United States.

Section HYDRACARINA

The third section of the suborder Prostigmata is the Hydracarina. These mites resemble the Trombidoidea in many respects altho the exact relationship is uncertain. It is composed of two families of purely aquatic mites, the Halacaridae or marine mites, and the Hydrachnidae or fresh water forms. The former has no representatives in Ohio. They are found in all oceans but seldom in water not connected with the ocean. A very few forms are recorded from fresh water. The number of species is relatively small.

The family Hydrachnidae includes many genera and a large number of species. Little has been done on the life history of the group and most of the systematic work has been done in Europe. Dr. Ruth Marshall has contributed several excellent papers on the Arrhenuri of North America and Dr. Robert Wolcott has added a number of papers on various genera in our fauna.

These mites usually have a short and almost spherical body. There is no sharp division between abdomen and cephalothorax. The legs, which are usually seven jointed, generally arise in radical proximity near the anterior end of the venter. The coxae are

often fused to form a coxal plate. The tarsi usually end in two claws, while numerous long hairs arranged either singly or in tufts along the legs aid the mites in swimming. This process is usually eratic and slow. Nearer the posterior end of the venter is the genital area, margined on either side by flaps or reniform areas provided with sucker-like disks, the number and arrangement of which are useful specific characters. One or two pairs of simple eyes are usually present. The body integument may be soft and leathery or hard and is often finely pitted or otherwise ornamented. The mouthparts are frequently hidden from view by the projecting edge of the cephalothorax. The pyriform beak is seldom conspicuous. The mandibles are two jointed and may terminate in a claw-like joint or be elongated into stylets. The four or five jointed palpi frequently have the distal joint long and folded back against the penultimate. These organs vary greatly in shape and are much used in classification.

Most species are free-living and predaceous; but several genera, Unionicola in the gills of mollusks and Hydrachna and several other genera on aquatic insects, are parasitic. The latter frequently attach to adult insects and when these leave the water the mite parasites soon die from exposure to the air.

The eggs of these mites are usually spherical. They are deposited on various submerged supports. As the embryo develops the egg membranes separate and a deutovius stage results. The six-legged larvae are usually some shade of red or green and only slightly resemble the adults. The short hooked palpi enable them to retain a hold upon plants, etc. As engorgement procedes the legs are seemingly absorbed and the mites appear as egg-shaped sacks. These are often found attached to aquatic insects. Within these a quiescent stage is formed from which the adults will appear.

I have records of eight species and one variety in six genera taken in Ohio. Seven species and one variety were taken in Buckeye Lake, Ohio during late August, 1923. Dr. Marshall has made determinations of these collections.

The genus *Arrhenurus* has a short, entire, shield-shaped capitulum; the fifth joint of the short, stout palpi forms a claw to an apical extension of the fourth; the eyes are widely separated and not in a capsule; and the thick integument is pierced by large pores. These mites are usually bluish-green in color.

Arrhenurus trifoliatus Marshall
Trans. Amer. Micr. Soc., XXVIII, 1908, p. 115

This is a dull olive green species measuring about 1.02 mm long by .75 mm broad. I have taken several specimens among the plankton in the west and southwest lagoons of Buckeye Lake. The species is recorded from several of the north central states and is probably well distributed in this region and southern Canada.

Arrhenurus marshalli Piersig
Zool. Cent. XI, 1904, p. 210

A number of specimens ranging in color from pale brown to olive green were taken in various parts of the western lagoons of Buckeye Lake, Ohio. All the material came from the bottom of shallow lagoons covered with quantities of decaying vegetable material. It is also reported from Bass Island in Lake Erie and from numerous places in the United States and southern Canada.

The species in the genus *Unionicola* were long grouped under Atax, but the latter name is now invalid in this sense. These mites have but few swimming hairs on the legs; the genital opening is at the tip of the body and the plates at either side of it bear more than three easily distinguished disks. The epimera are usually not united into one plate and the fifth palpal joint does not form an opposable claw to the preceding. Species are recorded from all parts of the world and are always parasitic in the gills of fresh water mollusks during some part of their life.

Unionicola crassipes Muller
Zool. Dan. Prodr. 1776, 2254, p. 189

This species is peculiar because of the great length of its legs. Specimens in my collection range from pale brown to olive green and almost black when alive. Mature females are about 1 mm in length, the males but half this size. It is one of the most common species in Buckeye Lake during late August. A large number of mature males, females, and deutonymphs were taken in the upper three feet of water. The species is also recorded from Europe, Palestine, several of the north central United States, and southern Canada.

The genus *Neumania* are mostly soft bodied mites. The epimera are large and grouped; the palpi are small, terminating in three or four finger-like processes; the fore legs are stout and bear numerous dagger-like spines set in papillae on the mid-joint.

Neumania distincta Marshall
Trans. Wis. Acad. Sci. Arts. Lets., XX, 1922, p. 210

This is a large species, the male measuring a little more than 1 mm in length. I have taken no females, and Dr. Marshall states that none are on record. The genital plates are characteristic being narrow near the middle and extending far out from the genital opening. But one specimen, olive green in color, was taken in the southwest lagoon of Buckeye Lake. It is also recorded from Wisconsin but appears to be a rare species.

Neumania punctata Marshall
Trans. Wis. Acad. Sci. Arts. Lets., XX, 1922, p. 211

The females of this species are about .75 mm long. The genital plates are large and lie close to the fourth epimera. I have but one specimen, a pale brown male, from shallow water in the southwest lagoon of Buckeye Lake. Dr. Marshall records the species from Wisconsin.

The genus *Limnesia* contains but few species, however, from all parts of the world. They are peculiar in having no claw on the posterior pair of legs, which terminate in a long slender spine. The body is usually soft and highly arched. The two eyes on either side are not fused as is often the case in mature hydrachnids.

Limnesia paucispina Wolcott
Trans. Amer. Micr. Soc. XXXV, 1903, p. 98

Dr. Wolcott distinguishes the species by the stouter palpi with a short papilla on the second segment; the scarcity of spines on the appendages; and the character of the genital area. The females are about 1 mm long and .8 mm broad. This is a common species in Buckeye Lake during late August. Many males and females were taken swimming in or near plankton. It is probably a fairly common species in the north central states.

Limnesia histrionica var. wolcotti Piersig

These are pale green, solf-bodied mites measuring about 2 mm long by 1.7 mm broad. The species *L. histrionica* Hermann is widely distributed thruout Europe and North America. Two specimens of the variety, both immature females, were taken near the bottom of a shallow pool in the southwest lagoon.

In *Tyrrellia* there are no swimming hairs on the legs; the fourth pair end in claws; the second palpal joint bears no spines;

the epimera are in four groups with the genital area lying between the fourth pair; the distal palpal segment is not opposable to the preceding.

Tyrrellia circularis Koenike
Abh. Ver. Bremen, XIII, 1895, p. 199

This is a greenish species about 1.3 mm long by 1 mm broad. It is recorded from North America and to my knowledge is the only species in the genus. The type material is from Illinois. Brain took the species from a board in the Black Channel near Cedar Point, Ohio, August 15, 1912. It is not a common species.

Piona, long known as *Curvipes,* contains many species in all parts of the world. The body is soft and all the legs have swimming hairs. The hind epimera are smooth; the palpi smaller than leg I and terminating in 2 or 3 small claws; the fourth segment has two papillae below; and the genital opening is not at the tip of the body.

Piona rheigardi Wolcott
Trans. Amer. Micr. Soc., XXIII, 1902, p. 235

This small, blue-green species is about .8 mm long by .6 mm broad. The palpal form and the genital area distinguish it from other species. It is quite common in all shallow waters of Buckeye Lake, and is recorded from other places in North America.

In addition to these records I have undetermined material in *Hydrachna, Diplodontus, Sperchon, Hydryphantes,* and *Torrenticola.*

Suborder PERITREMATA

Those mites in which the tracheae open on each side of the body thru a peritreme or stigmal plate, usually located above the posterior coxae, constitute this suborder. The integument is usually leathery or provided with chitinous plates. It is comprised of two superfamilies including some of our most injurious species.

Superfamily Ixodoidea

Members of this superfamily are commonly called ticks and are the most common of mites. The tracheal opening is in a discoidal plate; the integument is leathery; and the hypostome is a large dart-like structure projecting from the anterior end of the body and armed with recurved hooks. Because of the parasitic habit of this group of mites they have been intensively studied and the biology of many species is well known. The species are all

quite large and even in the larval stage they can be detected with the unaided eye. To even review the general characters would require a large volume and so will not be undertaken here.

Unengorged ticks are roundly triangular in shape but when greatly engorged with food or eggs the female assumes the shape of a castor bean and seems to lack legs and a capitulum. They range from 2 mm in small unengorged species to 20 mm in large distended ones. The capitulum bears a somewhat complex structure, the proboscis. The mandibles, the sheath enfolding them, and the hypostome bearing the recurved hooks form this structure. The arrangement of the hooks is of value in specific identification. In feeding, the hypostomes and mandibles are inserted in the host, the hooks of the former making detachment by force nearly impossible without removing a bit of host tissue or injuring the tick. The four jointed palpi are inserted at the sides of the proboscis. The basal and terminal joints are small and quite obscure.

On the abdomen, just posterior to the capitulum, most species bear a roughly hexagonal corneous plate or scutum. In the males this covers most of the dorsum but in the females it is quite small. Several porose areas, also on the dorsum, are aids in identification. Their function is uncertain altho all mature females of the family Ixodidae have them. Some genera show eye-like spots on the lateral margin.

The posterior abdominal margin of many species has a folded or lobed appearance due to a number of short furrows. These are most apparent in males and unengorged females. When the latter are engorged the furrows are scarcely discernable. The anterior ventral opening is the genital, the posterior being the anal. The males of many species show various chitinized plates about the anus. The legs, usually six jointed, are slender and arise near the anterior end. Each terminates in two large claws at the tip of a pedicel. A median pulvillus is usually present. Haller's organ, a membrane-covered pit on tarsus I, is thought to be auditory in function. A wide range of color patterns is to be found in these Acarina and this character is seldom of taxonomic value.

All ticks are parasitic during a part of their life. A large number of mammals, birds, reptiles, batrachians, and a few insects serve as hosts. Usually but little injury results to the host except the loss of blood and this is not serious except where the parasites are very numerous. Those forms which transmit fatal diseases take a toll placed by some as high as $150,000,000 annually.

Family Argasidae

This family is separated from the other in this superfamily on the basis of its cylindrical, four-segmented palpi, and by the absence of a dorsal scutum and the tarsal pulvillus. To my knowledge Ohio does not fall within the area of distribution of any of the several species. The fowl tick and the spinose ear tick of the United States and Mexico, the "miana bug" of Persia, and the chicken tick of Brazil and elsewhere belong in this family. The species lay fewer eggs than the Ixodidae and are not nearly so numerous. Several species are implicated in the transmission of diseases of man, and the fowl tick infects chickens with the causal organism of spirochaetosis.

Family Ixodidae

In this family the palpi are flat or grooved and the scutum and pulvillus are present. Nearly fifty species are known from the United States while the fauna of most other temperate and tropical regions is equally rich in species.

Temperature greatly influences oviposition, incubation, and molting, but affects only slightly the periods of engorgement on warm blooded hosts. Death overtakes the female soon after she finishes depositing her 1,000 or more eggs. These are usually laid on the ground during the spring or fall depending upon the species. Upon hatching the larvae ascend some support where they may remain for some time. A suitable host brushing this support receives the parasites, which attach and engorge within a few days. Many interesting variations of the process of selecting a host are on record. After engorgement many species fall to the ground where they seek out some sheltered situation to molt. The Texas fever tick and some others molt upon the host. A few species pass the first molt on the host and the others on the ground. In any case the larval skin splits in time and the eight legged nymph appears. Where off the host these ascend a support to attach to the first suitable host that passes. After a brief feeding period they again molt on or off the host, depending on the species, and after a time the adults appear. They must also seek a host before mating or ovipositing. The advantage of having all or even one of the molts occur on the host is evident, since the chance passing of a host plays such an important part in the life of those molting upon the ground. But a few of the possible millions of ticks ever mature.

Many of the Ixodidae are known transmitters of various diseases. The relation between *Margaropus annulatus* Say and Texas cattle fever in nearly all parts of the world; *Amblyomma hebraeum* Savigny and "heart water" of cattle in Africa; *Haemaphysalis leachi* Koch and malignant jaundice of dogs in Africa; five species of *Rhipicephalus* and African coast fever; *Ornithoderos moubata* Murray and African relapsing fever; and between *Dermacentor andersoni* Stiles and the Rocky Mt. spotted fever, have been proved, while many others seem highly probable.

Where present in but small numbers hand picking may be resorted to with good results. Where wholesale treatment of stock is desired, dipping in vats of some suitable disinfectant has been found satisfactory. Starvation of the ticks by rotation of the grazing areas has been found effective against the Texas cattle tick. Various quarantine measures have also been applied with good results.

Birds are an important natural agency of control in many areas where the ticks abound. Some insects are predaceous upon tick eggs. Rodents may destroy numbers of the young and adults. Several Chalcid parasites have been reared but as a whole they are of little importance. Variations in temperature and moisture account for the death of many ticks in different stages.

Few ticks occur in Ohio and but one of these is common. Fortunately it is not known to transmit any disease.

In the genus *Ixodes* there is a curved groove extending from in front of the anus to the hind margin at either side; the stigmal plate is nearly circular; there are no posterior marginal festoons; the legs are shorter than the body; and the third palpal joint is longer than broad and slightly tapering. Both molts are passed off the host.

Ixodes scapularis Say
Jour. Phila. Acad., II, 1821, p. 78

This is commonly called the "black legged tick." Females are dark brown in color and males nearly black. The scutum and legs are black in both sexes. I have no records of this species for Ohio but its probable range includes the State. It is reported from most of the southeastern states on dogs, cattle, deer, sheep, and horses, and in its immature stages, from a number of birds.

Haemaphysalis has a lobed appearance of the posterior abdominal margin; the groove is behind the anus; there are no anal

plates in the male; the sides of the capitulum are not angulate; and the outer angle of the second palpal joint is acutely produced. It falls from the host before each molt.

Haemaphysalis leporis-palustris Packard
1st Ann. Rpt. Peabody Acad. Sci., 1869, p. 67

The species is commonly called the "rabbit tick." Both sexes are dark brown or black without lighter markings. I have no records of the species from Ohio altho its probable range includes all of the United States. It is the most common tick found on the seven species of rabbits, whence its name, usually attaching to the ear. It is also recorded from the house cat, and from quail, robbins, and meadowlarks. The young are reported from several other birds, where they usually attach about the head.

Haemaphysalis chordeilis Packard
1st Ann. Rpt. Peabody Acad. Sci. 1869, p. 67

This is commonly called the "bird tick" because of its usual occurrence on bird hosts. Males have the scutum light gray in color shading into amber anteriorly, with the marginal strip bluish-white; legs and capitulum are amber. In females the scutum is unmarked and the body color is reddish brown. It falls for each molt.

It is probably a generally distributed species. I have but one record from Ohio and that on rabbits at Ostrander. This seems to be an uncommon host. It is most often reported from quail, meadowlarks, nighthawks, blackbirds, jack daws, killdeers, the domestic turkey, and other ground frequenting birds. Infestation is usually heaviest about the head. It may become a pest of turkeys where these are allowed to run in open fields and woods. There are records of almost total loss of flocks of turkeys. Hand picking has given best results. Death of wild hosts due to this species is not known.

Margaropus has the sides of the capitulum angulate; the ocelli present; male bearing anal plates; the palpi short with acute transverse ridges. The ticks of this genus are important transmitters of various diseases.

Margaropus annulatus Say
Jour. Phila. Acad., II, 1821, p. 78

This is commonly known as the "North American cattle tick." Females are dark dull brown in color with reddish scutum and legs. In the male, which is reddish brown, the legs have paler articula-

tions. It is confined to the southern and southeastern states and Mexico in its distribution and is being combatted by rigorous quarantine measures. I have but one record for Ohio and that from imported cattle in the Cleveland stock yards during 1906.

The genus *Amblyomma* is similar to the preceding, but differs in having the outer angle of the second palpal joint, which is twice as long as broad, not produced; the male coxae not enlarged and this sex without anal plates; the basal part of tarsi I, II, and III is shorter than the apical; and the eyes are marginal.

Amblyomma americanum Linnaeus
Syst. Nat. X, 1758, p. 615

The "Lone Star tick" takes its common name from the silvery spot on the apex of the scutum of the female. The dorsum of the male also shows a silvery marking about the posterior margin. These markings do not appear in the nymphs until a few days prior to molting. Otherwise the color is brown. Molting occurs off the host. The area of distribution includes the eastern and southern states. I have material from Bellefontaine, Ohio but no host data. It seems most common on dogs, cattle, man, and horse, but is also reported from the deer, goat, hog, mule, sheep, turkey, and numerous other vertebrate hosts. The species is of considerable economic importance because of its irritation and the consequent suppuration resulting in most of its hosts following an attack. Application of any standard dip by mopping or dipping is effective.

In the genus *Dermacentor* the second palpal joint is barely longer than broad; coxae IV of the male are enlarged; and the basal part of tarsi I, II, and II is subequal to the apical part.

Dermacentor variabilis Say
Jour. Phila. Acad. II, 1821, p. 77

Commonly known as the "dog tick" this is our most common species and few people have gone into the field without bringing home at least one of these parasites. In the male the dorsum bears irregular white marks. In the female the scutum bears a marginal white band and there is a brown marginal stripe near each eye. The general color of each sex is reddish brown. All stages molt on the ground.

I have taken the species from man and dogs in a number of Ohio localities during all but the winter season. They are frequently found on and beneath loose bark of trees and logs in well

drained areas. The species occurs thruout the United States except for the Rocky Mt. region. It is also reported from Alaska and Labrador. The dog is its most common host but the squirrel, racoon, ox, opossum, man, and other vertebrates serve as hosts. It is of no economic importance except as secondary infection may follow its attachment to man. It is not known to transmit any disease.

Superfamily **Parasitoidea**

This group includes all those mites which usually have a long tubular peritreme; a small hypostome lacking recurved teeth; and a wholly or partially chitinized integument. Banks records but four families of these mites, two of which are represented in our fauna. Several subfamilies have been elevated to family rank. The terms Gamasoidea and Gamasidae, long employed for these mites, are now preceded by those used here. The synonomy is badly confused, largely due to the number of descriptions based upon immature forms. All of the Dermanyssidae are parasitic and many of the Parasitidae and Uropodidae have this habit developed to varying degrees. Many of the taxonomic characters are monosexual adding to the difficulty of identification.

The members of the subfamily Halarachninae of Banks have a peculiar parasitic adaptation. The species of Halarachne are parasitic in the bronchial passages of seals; and those of Pneumonyssus in the lungs of some old-world monkeys. Other interesting adaptations of parasitism will be found in literature but as a whole little biological work has been done in this group.

Family **Dermanyssidae**

These mites may be characterized as having the mouthparts adapted for piercing; the chelicerae devoid of either one or both of the chelae or of all teeth but with recurved hook-like structures sometimes present; one or more dorsal and ventral plates present; and each tracheal trunk opening thru a peritreme on the ventral side of the body. The group is parasitic upon vertebrates. There are but three species thus far recorded from Ohio.

In the subfamily Liponyssinae the chelicerae are without hooks or barbs and are shear-like in both sexes. We have representatives of two genera.

The genus *Ceratonyssus* has the basal segment of the palpus in the female with a horn-like process; the dorsal shield of the female divided, the posterior part being large and about as long as the anterior. Ewing includes but three species in the genus.

Ceratonyssus ceratognathus Ewing
Proc. U. S. Nat. Mus. LXII, 1922, Art. 13, p. 11

This mite averages about .65 mm long by .4 mm broad. Unengorged mites are of a pale brown color, but when engorged they are considerably darker. I have a large number of specimens taken from the common bat at Chillicothe, Ohio during July. All hosts thus far captured have been infested. The mites are most numerous on the ventral side of the elbow joint of the wings. They move very rapidly among the fine hairs when disturbed and if removal is attempted they seem to attach themselves firmly to the host, possibly by grasping the hairs with the chelicerae and claws. The type material is from Batesburg, S. C. on a small bat. Distribution may very probably coincide with that of the host and there may be several host species.

In the genus *Liponyssus* the dorsal shields in both sexes but partially cover the body; the legs are not stout; tibia I is more than one-half longer than broad; femora I and II are usually spinose above; body of the female is without constrictions and an incomplete groove behind the insertion of the last pair of legs.

Liponyssus bursa Berlese

This is commonly known as the "bird mite," and is a smaller species than the common poultry mite. The anal plate of the female is pointed in front but not triangular; the anal setae are situated in front of a transverse line drawn at the posterior rim of the anus but much behind one drawn at the anterior margin; the anus is situated more than two-thirds its greatest diameter from the front margin of the anal plate; the anal plate of the female is less than one-half as broad as body at middle of the dorsal shield and two-thirds the greatest width of the cephalothorax.

The general habits and methods of control are similar to the following species and will be discussed there. It is practically cosmopolitan in its distribution and I have several records from poultry in Ohio. All North American host records are from poultry, altho in Europe it attacks pigeons, canaries, etc. Reproduction is rapid and attacks are often fatal to poultry.

The genus *Dermanyssus* has a large undivided dorsal shield in both sexes. The chelicerae are needle-like in the female and composed of two closely adhering elements. In the male the chelicerae may be variously formed but are never needle-like, both arms being present. The legs are long and slender. The anus is usually situated in the posterior half of the anal plate.

Dermanyssus gallinae Megnin
Parasit., 1880, p. 115

This species is separated from the others in the genus by having a long sinuous peritreme extending beyond the second coxa. It is a quite common species, being cosmopolitan in distribution. I have several records from Ohio. Because of its common occurrence and economic aspect the biology of the species is quite well known.

The poultry mite is most common in dry or fairly dry situations. It is almost exclusively nocturnal in its feeding habits. It is a truly parasitic species and requires blood for successful development.

Oviposition begins shortly after feeding. The small oval eggs are pearly white in color and are usually deposited in cracks about the hen roost. A mature female deposits from two to three dozen eggs, usually feeding six or more times during the oviposition period. In summer the eggs hatch in about two days. The hexapod larvae are nearly white in color. Movement is quite slow. They feed for a day or so and then molt.

The first nymphal stage has eight legs and is quite active. It feeds very soon after appearing and is of a pale brown color. When engorged it becomes a bright red color due to the ingested blood of the host. If feeding has not been delayed another molt will occur within 24 hours. This second nymph soon becomes active and again seeks out a host. Following a third engorgement and molt the adult appears. Adults measure about .7 mm long by .4 mm broad. Mating may take place as soon as the integument has hardened, but oviposition occurs only after feeding. Mature mites are brown or reddish in color and vary somewhat in size, the males being the smaller.

The complete life cycle may be passed in ten days but variations in temperature and moisture affect the length of the various stages to a marked degree. Without food, adults will live from two to three months. Reproduction is quite rapid and from a few unobserved mites a poultry farm not properly attended may soon be overrun.

The species is also known to attack turkeys, pigeons, sparrows, and other birds, but chickens appear to be the preferred host. Man and other animals visiting an infested hen house may find themselves the temporary carriers of a large number of mites, which, altho not attacking, may become quite irritating as they

crawl about over the body. This at once suggests a possible means of distribution altho the infested hen or shipping coop is the most usual channel thru which spread occurs.

Many substances have been used to control this species but few have proved satisfactory. Either pure coal-tar creosote, or carbolineum mixed with kerosene to make a 20 percent mixture, thoroly sprayed into all cracks and crevices of walls, nests, roost supports, etc., has given perfect control and the efficacy of either is lasting. Birds must not be sprayed with these materials.

Various natural enemies have been recorded. I have observed pseudoscorpions preying upon the mites. Others have observed the same. A few ants also prey upon them.

Family **Parasitidae**

In these mites the forelegs are inserted at one side of the camerostome, the dorsum not projecting beyond this orfice. They have stout chelicerae with large chelae and are rarely parasitic. The group is well known to insect collectors since many species live in a somewhat symbiotic relationship with insects. The family is rich in genera and species. The North American fauna is but little known altho there are upwards of 150 species recorded from this country. Berlese has described very many species from all parts of the world. Michael has contributed several excellent papers on the internal anatomy of the group.

All the species thus far studied are oviparous. The eggs are usually deposited in some sheltered place frequented by the adults. They are quite small and not numerous. Upon hatching a small, milk-white or nearly hyaline colored larva appears. Within a few days it molts to appear as an eight-legged, asexual nymph. The nymph molts in a week or so and except for various chitinizations of the integument and a slightly larger size does not vary greatly from the preceding stage. No quiescent stages have been observed to precede the molts. After another week or so a third molt occurs and the adult appears. Michael has fed the nymphs and adults small living and freshly killed Arthropods. Those that seem so thoroly at home on an insect may secure all their food by captures made as the carrier searches for its own food. During frequent observations I have never observed them to feed upon the carrier nor in any other manner.

My collections comprise many more species than those recorded here. Some may be new to science. Few species in the family are cosmopolitan. Nothing is known of the detailed biology of our

Ohio forms, altho I have some work in progress. They may, as a group, be considered as predaceous and possibly parasitic in a few cases but otherwise have little economic importance. I will use Banks' characters for the most part.

In the genus *Euzercon* the anal aperture is in the post-ventral plate and the venter has lateral chitinous plates extending to the posterior margin of the body. The dorsal plate is entire.

Euzercon latus Banks
Proc. Wash. Ent. Soc., XI, 1909, p. 135

Banks originally described the species in the genus *Celaenopsis,* but I cannot correlate the characters with those of that genus. Euzercon is a widely distributed genus and is usually found upon beetles.

This is a very common species upon *Passalus cornutus.* I have never taken the host in Ohio without finding some stage of this mite attached or present on it. When mature it is little more than 1 mm in length and of a pale brown color. A single host may often carry as many as 50 mites. It is distributed thruout the north central and eastern United States and southern Canada.

Macrocheles is a genus of common mites found among debris and on various insects living in debris. The anal and ventral plates are united and there are no separate lateral ventral plates. The dorsal shield is entire and the legs are longer than the breadth of the body.

Macrocheles clavisetosus Ewing
Trans. Acad. Sci. St. L., XVIII, 1909, p. 64

This is a dark reddish brown species, measuring about 1 mm long by .7 mm broad. It can move very rapidly. I have taken a number of specimens from plant debris in fields and woods about Chillicothe. Ewing records it from Illinois.

Macrocheles sublaevis Banks
Jour. Ent. Zool., VI, 1906, p. 59

This is a small species, being but .6 mm long. It is pale brown in color. Brain collected the type material at Cedar Point from *Ligyrus relictus* and *Boletotherus bifurcus* in June. I have no other records.

Laelaps has no representative recorded from Ohio. It is mentioned here because *L. echidninus* Berlese is parasitic upon rats

and cosmopolitan with its host. The species is a possible transmitter of plague and is known to transmit a rat disease. Other species of *Laelaps* are parasitic upon rodents.

Echinomegistus has a nearly circular body and a series of alternating long and short spines set in the lateral and posterior margins; the venter has no separate lateral plates; and the dorsal shield is entire. All the species occur on insects.

Echinomegistus wheeleri Berlese
Redia I, 1903, p. 398

I have a single specimen taken from a camel cricket, *Ceutophalus uhleri* Scud. which resembles Berlese's figures and descriptions in all details except the arrangement of the marginal spines. This character is probably variable. The type material was taken from ants in Connecticut. My specimen was taken near Laurelville, Ohio, the host living in a dry stump. The mite is dark brown in color and very active. Several escaped before I could capture them.

In the genus *Parasitus,* tarsus one may have a caroncle or claws or both; the peritreme is long; the dorsum has two large shields; the male genital aperture is in front of the sternal shield; leg II has processes below; vulva often large; claws of legs long and pedicellate; female ventral shield not united to the genital, the latter triangular and anteriorally pointed. This genus contains a large number of species from all parts of the world. I have but one to record from Ohio.

Parasitus inaequalis Banks
Jour. Ent. Zool. VI, 1915, p. 59

This is a pale yellowish species measuring slightly more than 1 mm long. Brain captured the type material on *Necrophorus orbicollis* at Cedar Point. There seem to be no other records.

Polyaspis has the legs, which are armed with claws and caroncles, about as long as the body. Other characters are minute.

Polyaspis lamellipes Banks
Jour. Ent. Zool., VI, 1915, p. 58

In this species the body is not twice as long as broad. It is pale brown and measures about .7 mm long. Brain collected the type material from *Orthosoma brunneum* at Cedar Point, Ohio.

Coproholaspis is one of four subgenera created by Berlese for the genus *Macrocheles*. After noting the numerous variations that occur in the characters used the division does not seem justified. The present genus is the most logical subdivision. In it the sternum does not show strong reticulations but is transversely furrowed between the second set of pores. There are two or four porose areas in the anterior and posterior angles of the venter.

Coproholaspis muscae Ewing
Ent. News, XXIV, 1913, p. 454

This is a dark yellowish brown, robust species about 1 mm long. Ewing records it from New York and Oregon on *Musca domestica*. It probably gains access to this host from the latter's habit of feeding and breeding in decaying vegetable and animal matter. In Ohio I have many specimens from *Canthon laevis*, a dung beetle that is also found about certain forms of waste vegetable matter. The species seems to have a general distribution in the United States.

Pergamasus is composed of rather large dark brown species in which the venter is strongly reticulated into irregular cells.

Pergamasus crassipes Linnaeus
Syst. Nat., 1758, p. 616

This mite is fairly common in Europe but does not appear to have been previously recorded from this country. I have taken a number of specimens during November beneath the sheaths of dead corn stalks lying on the ground at Geneva, Ohio. They are dark brown in color and 1.5 mm long.

In *Celaenopsis* the tarsi have no claws or caroncles; the legs are not much longer than the body; the dorsal shield is entire; the lateral chitinous plates on the venter extend to the posterior margin; and the anal aperture is in the ventral plate.

Celaenopsis americanus Banks
Proc. Wash. Ent. Soc., VII, 1906, p. 137

This species is recorded from several localities in the central and eastern states. Brain records it from a histerid beetle, *Hololepta sp.* at Cedar Point, Ohio. Adults are yellowish brown in color and a little less than 1 mm long.

Celaenopsis pedalis Banks
Proc. Wash. Ent. Soc., XI, 1909, p. 135

This species is similar to the preceding and differs only in minute characters. Brain records it from Cedar Point, Ohio on *Passalus cornutus*. The type material is from the larvae of *Pelidnota punctata* taken at Guelph, Ontario. The species is probably distributed thruout the northern United States and southern Canada.

The genus *Seiulus* is similar to Parasitus but leg II of the male has no ventral processes; the vulva is small; and the leg pedicels short. Both claws and caroncles are present and the hind femora are not calcarate. The dorsal shield is entire; the anal plate separate in both sexes; the ventral plate usually large; the epistome blunt. These are mostly small simple mites and frequently are recorded as predaceous upon thrips and red spiders.

Seiulus hirsutus Koch
Crust Myr. Arach. Deutsch., fasc. 24, fig. 12, 1835

This pale brown mite averages about .7 mm long. I have one specimen from a mass of webs of *Crambus caliginosellus* at Chillicothe, Ohio, June 16. Movement is very rapid.

Seius is similar to the preceding but the species are smaller, being about .5 mm long, and paler colored. They usually bear a pair of prominent posterior bristles. The species are common.

Seius pomi Parrott
N. Y. Agr. Exp. Sta. Bul. 283, 1909

This small species is about .4 mm long. It is a common predator of various red spiders and Eriophyid mites, feeding on both the eggs and the active mites. It deposits its eggs on the lower side of the leaves. All stages are passed upon the plant except hibernation which probably occurs among fallen leaves or in bark crevices. I have several records from Ohio where it is always associated with some plant feeding mite. It is common in the field and in greenhouses thruout the northern United States.

Family **Uropodidae**

The body integument is coriaceous, usually depressed, and often possessing impressed foveae on the ventral surface for the reception of the legs when these are folded under the body. The lateral projections of the dorsum frequently hide the appendages

from view. The mandibles terminate in delicate chelae and are often highly retractile. The first pair of legs and the mouthparts are inserted within the same body opening. The nymphs are usually found on insects to which they adhere by an anal pedicel composed of excreted material. In this stage they are not parasitic and it is doubtful whether at any time they are more than symbionts. They can detach at any time by excreting fresh material. Much has been written of this quiescent stage, especially of *Uropoda americana* Riley which was thought to destroy the Colorado potato beetle, but since these forms do not feed they can do nothing more than slightly encumber the insect to which they are attached. Wood boring insects, flies, and Scarabaeid beetles are most frequently the carriers of these mites. Some genera are known to feed upon bacteria and minute fungi. Many species are known, and much literature has been added in describing as new the immature forms. Three genera are thus far known from Ohio.

Uropoda has the impressed ventral foveae, leg I has claws and a caroncle, there is no perigenital scutum, and the dorsum is smooth.

Uropoda folsomi Ewing
Trans. Acad. Sci. St. L., XVIII, 1909, p. 70

This is a dark brown species about 1 mm long. The body is slightly pointed behind. I have the species from rotting tulip bulbs in a greenhouse at Youngstown, Ohio. It is also known from Illinois.

Uropoda illinoisensis Ewing
Trans. Acad. Sci. St. L., XVIII, 1909, p. 70

This species is brown, slightly oval in shape, the body rounded behind, the antero-lateral margin convex, and about .75 mm long. I have specimens from under loose bark of dead *Acer saccharum* roots at Chillicothe, Ohio. It is also recorded from several places in Illinois under bark of maple and sycamore.

The genus *Uroplitella* differs from the above in having a perigenital scutum about the genital plate.

Uroplitella circularis Berlese

This species is brown, nearly circular in outline, and .8 mm long. One specimen was taken from an ant, *Formica sp.* at Chillicothe. No other ants in the colony carried mites.

Uroplitella pennsylvanica Berlese
Redia, I, 1903, p. 251

Only minute characters separate this species from the preceding. I have several specimens from *Formica fusca* at Columbus, Ohio during February. They were quite abundant on the ants in this one colony.

The genus *Trachyuropoda* has the foveae present; the legs are armed with claws and caroncle; the perigenital scutum is wanting; and the dorsum is roughened and shows no sutures.

Trachyuropoda longa Ewing
Bul. Amer. Mus. Nat. Hist., XXXVII, 1917, p. 158

The species is reddish brown in color and about twice as long as broad, measuring .75 mm in length. The type material is from Xenia, Ohio, under a stone. It is apparently rare.

Suborder HETEROTRACHEATA

In a large number of mites there are two types of tracheae usually present, the branched and the unbranched, which open ventrally either near the base of the rostrum or at the acetabula of the legs. A few forms have no tracheae. These together comprise this suborder which is divided into two sections. These mites are distinct from all others in having two large dorsal pores, called pseudostigmata, on the cephalothorax, from each of which arises a pseudostigmatic organ. They comprise the superfamily Oribatoidea.

Excluding the ticks, the taxonomy of our North American forms is better known than that of any other group of mites. Banks and Berlese have added some species and Ewing has prosecuted a most diligent study of the group. But it is to Michael of England that we must turn for a detailed life-history and morphological study of the group altho he treats only of European forms.

These mites are commonly called "beetle mites" because of the usually hard integument and not because of any specific association with beetles. All are relatively small and of obscure habits, most forms being strongly negatively phototropic. Altho commonly found beneath debris in woods and fields there are some forms that are aquatic or semi-aquatic in habits. No forms are known to affect man in any way. They are known from all parts of the world but are apparently most numerous in temperate zones.

As might be supposed, there is a wide diversity of size, shape, and structure. These have their advantage to the student of taxonomy since they present an array of characters useful for specific determination.

Most species are oviparous, but some are known to have viviparous and ovoviviparous habits. There is no proof of parthenogenesis among these mites. In many species a deutovium stage in the development of the egg allows for a normal increase in the embryo before hatching. Eggs are usually elliptical in shape.

The larvae are quite minute, six-legged creatures with but little color. The tarsi bear but one claw each. The larvae resemble the nymphs to a very marked degree except for their hexapod condition. The mites remain in the larval state for periods of from two weeks to several months. Previous to molting the claws are sunk into the substrata of some crevice and the mite becomes quiet.

Various species cast the larval skin in different ways, the nymph always appearing as an octopod form with monodactyl tarsi and soft integument, usually of a pale brown or pink color. In this stage the mite attains its size and, in many species, the most ornate integumental processes which have no apparent function but aid greatly in a more perfect concealment. The nymphs of some species exude an adhesive substance which entangles numerous small particles and gives the mite a quite grotesque appearance. Some mites seem able to select the material composing this load. Other nymphs retain the cast skins following each ecdysis and these in serial arrangement are carried about on the back. Again many forms are quite smooth and highly polished.

The nymph usually molts three times; after the third molt the adult appears. These are frequently quite modest appearing creatures when compared with their nymphs. Most are black or brown in color and the integument is quite hard. In addition to the hard integument several genera have unique protective modifications. In *Oribata sp.* there is a chitinous development, wing-like in appearance, from either side of the anterior end of the abdomen. These are called pteromorphae and can be folded tightly against the body covering the posterior legs. Various other modifications of the dorsal integument into projecting plates and ridges also appear to aid in protecting certain of the appendages. A most unusual arrangement is that found in the genus *Hoplophora*. The cephalothorax is not firmly attached to the abdomen above and may be deflexed to quite an angle. The venter is free to move up or

down, there being no lateral fusions with the dorsum. When alarmed the mite elevates the venter, making a depression for the reception of the legs, these fold into it, the cephalothorax folds over them and the mite appears as nothing but a minute particle of sand or debris.

There are numerous Oribatoidea to be taken in most any suitable habitat. In addition to those recorded for Ohio I have as many not yet determined. I will follow Ewing's latest arrangement and classification.

Section SCLERODERMA

In these mites the tracheae are present, tho often rudimentary; the cephalothorax is immovably attached to the abdomen, and the integument is usually well chitinized.

Family **Oribatidae**

The mites in this group usually have conspicuous pteromorphae. The genus *Oribata* is the only one thus far recorded from Ohio. It is characterized by having the pteromorphae usually truncate and not extending beyond the anterior margin of the abdomen; the lamellae are moderately developed and attached to the cephalothorax by their inner margins; tarsi are monodactyl.

Oribata curva Ewing
Psyche XIV, 1907, p. 113

This is a shiny black species measuring about .6 mm long. It is common in loose soil about Chillicothe during June and July. When disturbed these mites will make short jumps either impelled by the legs or by a quick closing of the pteromorphae which, striking against the substrata, throw the mite a short distance.

Oribata emarginata Banks
Trans. Amer. Ent. Soc., XXII, 1895, p. 7

This shiny dark brown species is about .7 mm long by .5 mm wide. The pteromorphae are smooth and deeply emarginate on the antero-ventral margin. They extend almost to the tip of the rostrum. The species is common about Chillicothe during June, July, and September under vegetable debris. It is a very common species thruout the United States and southern Canada.

Oribata nigra Ewing
Jour. N. Y. Ent. Soc., XVII, 3, 1909, p. 119

This smooth black species is about .8 mm long by .6 mm wide. The lamellae are wanting altho there is a pair of lateral lamellae very closely appressed to the dorso-vertex. There is a marked downward slope to the cephalothorax. This species is also common in southern Ohio during August and September in woodlands. It is recorded from Iowa and Illinois.

Oribata pratensis Banks
Trans. Amer. Ent. Soc., XXII, 1895, p. 6

This smooth reddish brown species is about .7 mm long. The pteromorphae are small, triangular, and do not project in front of the high convex abdomen. The tectal plate ends in a distinct transverse ridge. Brain captured the species on an old log at Cedar Point, Ohio, during August. It is also recorded from New York.

Oribata robusta Banks
Trans. Amer. Ent. Soc., XXII, 1895, p. 7

This species greatly resembles *O. emarginata* except that the margin of the pteromorphae is entire. The abdomen is high and convex. I have specimens from under bark on fallen logs at South Salem, Ohio during September. It is generally distributed thruout the north central and eastern states.

Oribata rugosala Ewing
Jour. N. Y. Ent. Soc., XVII, 1909, p. 120

This dark brown species is about .5 mm long. It differs from *O. nigra* in having the cephalothorax more nearly horizontal and the pteromorphae wrinkled and about one-third as broad as the cephalothorax. I have numerous specimens from insect tunnels in rotting wood. It is also recorded from Illinois.

Family **Nothridae**

These mites are characterized by having no pteromorphae of any kind. There are but four species in as many genera now known from Ohio.

Lucoppia has the lamellae present and usually placed laterally, either blade-like or straight chitinous ridges but not meeting in front tho they may be connected by a translamella.

Lucoppia magnipilosus Ewing
Jour. N. Y. Ent. Soc., XVII, 1909, p. 130

This reddish brown species measuring about .5 mm long has a long bristle-like pseudostigmatic organ; the legs inserted at the sides of the body and the lamellae about half as long as the cephalothorax. I have several specimens from leaf mold in woods near State Mills, Ohio. It is also recorded from moss at Parker, Illinois.

Damaeus has no true lamellae but may have irregular ridges. Some of the slender leg segments, aside from the femora, show swollen areas near their distal ends. The tarsi are monodactyl; the abdomen is circular in outline and separated from the cephalothorax; the genital and anal areas are near together.

Damaeus michaeli Ewing
Jour. N. Y. Ent. Soc., XVII, 1909, p. 129

This mite is smooth, chestnut brown in color, and about .5 mm long. All the leg segments show the swollen distal portion. There is no prominent tubercle on the distal portion of tibia I. I have numerous specimens from under loose bark on the ground and from under fallen leaves during May. It is also recorded from moss and under logs at Homer, Illinois.

Damaeosoma differs from *Damaeus* in having the abdomen oval and the anal and genital openings widely separated. The chelicerae are stout and the dorsum is quite smooth.

Damaeosoma corrugatum Berlese
Acari Nuovi, Man. 2, Redia, I, fasc. 2, 1904

I have taken the species during June and September. The former collection was from webs of *Crambus caliginosellus* and the latter from a dead larva of *Phyllophaga sp.* I find no other records of this species from this country.

Hermannia is similar to the preceding but has none of the leg segments swollen; the anal and genital openings are usually located in a ventral plate; the abdomen is arched and fully chitinized; and the adults never carry nymphal skins.

Hermannia bistriata Nicolet
Arch. Mus. Paris, VII, 1855, p. 397

This dark brown species is about .85 mm long, the dorsum is much sculptured and the abdomen bears four or six longitudinal ridges for its whole length, the outer of which are marginal. I

have one specimen from webs of *Crambus caliginosellus* at Chillicothe, Ohio, June 16. To my knowledge this is the only North American record. It is widely distributed in Europe.

Family **Hypocthonidae**

This group differs from Nothridae in having the dorsum of the abdomen, which is poorly chitinized, apparently divided into segmented areas by a series of sutures.

In the genus *Hypocthonius* the legs are normal and the tarsi monodactyl. The dorsum of the spherical abdomen is divided into two parts by a transverse suture but is not tessellated. It bears setiform hairs.

Hypocthonius rufulus Koch
Crust. Myr. Arach., fasc. III, t. 19. 1835

This tawny colored species measures about .7 mm long. The two dorsal abdominal divisions are nearly equal. I have taken this mite in rotting hickory nut husks and among fallen leaves in woods about Chillicothe, Ohio during May. It is also recorded from Arcola, Illinois, and Ames, Iowa. It is a common European species.

Section GINGLYMOSOMA

This group of mites have no tracheae and the cephalothorax is hinged to the abdomen and is capable of being folded over the ventral surface of the latter. It comprises but one family, the Hoplodermidae, including 10 genera. But one species is thus far known from Ohio.

Ginglymacarus has the tarsi monodactyl and the anal and genital covers separate. The cephalothorax has no dorsal median carina and the integument is smooth.

Ginglymacarus dasypus Duges
Ann. Sci. Nat. Ser. II, t. 11, 1834, p. 47

This is a drab colored species with tough integument and is usually more than .8 mm long. It is common in southern Ohio during the spring and fall in leaf mold. It is also recorded from Illinois and is widely distributed in Europe.

Section HETEROSTIGMATA

The mites in this section possess tracheae which open on the ventral surface of the body near the rostrum and the rudimentary needle-like mouthparts are situated on a cephalic papilla. The

abdomen frequently shows apparent segmentation. Ewing, following Berlese, gives this as a section of the suborder Heterotracheata and includes but two families in it, the Tarsonemidae and the Pediculoididae.

Family Tarsonemidae

The former includes a number of very small mites, many of which are quite destructive. The hind legs of the female Tarsonemid end in long hairs. This sex also possesses a clavate hair of uncertain function between legs I and II, which character alone separates them from all other mites. Some species have migratory nymphs which attach to insects. Taxonomic characters are mostly monosexual making specific determination quite difficult if the males are absent. There are several genera in the family but no species are cosmopolitan. I know of but one from Ohio thus far.

Many members of the genus Tarsonemus and allied genera are plant parasites producing galls and other malformations of buds, leaves, etc. Various species are known to affect the mango, pineapple, sugar cane, potato, peach, mushroom, rice, and various grass and other grain crops, as well as a host of shade and forest trees in various parts of the world. The mites may either injure the plant directly or carry disease producing fungi or bacteria on their bodies, which, gaining access thru the feeding punctures or otherwise, infect the plant often resulting in serious loss.

A number of species of this and allied genera have been taken in close association with various scale insects indicating the existance of a beneficial as well as of an injurious group within the same family. Some few are parasitic on and in various insects. *Acarapis woodi* Rennie, which causes Isle of Wight disease among honey bees in Europe, is parasitic in the tracheae of these insects.

Tarsonemus pallidus Banks
Proc. Ent. Soc. Wash., VII, 1906, p. 140

This pale brownish mite has the general characters of the genus and family. Females are about .2 mm long by .1 mm wide and the males are about ¼ smaller. I have found it in many Ohio greenhouses doing considerable damage to cyclamen plants. It also attacks chrysanthemum, geranium, snapdragon, verbena, larkspur, and other greenhouse and garden plants. The symptom on all of these is a marked curling of the leaves and flowers or buds. Various plant rusts often accompany a mite infestation. Since

cyclamen is frequently attacked it has given to the mite the common name of "cyclamen mite." "Pallid mite" is also used by some authors.

The eggs are usually laid during the night in the vein angles on the lower side of the leaves. They hatch in from three to seven days at normal temperatures. There seems to be but one larval stage, lasting from 3 to 6 days. About half of this time is spent in a quiescent state. Following this the adult appears and oviposition begins in a few days. A single female may lay 16 or more eggs. Parthenogenesis has been observed and may continue thru several generations. In greenhouses the cycle repeats itself thruout the year.

Mature plants that are heavily infested can hardly ever be saved. Where infestations have occurred during previous years florists should begin early in the season to apply "Black Leaf 40" at the rate of 1 part to 1,000 parts of water, adding soap at the rate of 3 pounds to 100 gallons. Many other remedies have been used but none are at present better and few cheaper than the above.

Family **Pediculoididae**

This family differs markedly from the preceding. The female has the hind legs terminating in claws and caroncles and when gravid she assumes enormous proportions. The species are quite prolific. There are but a few species in several genera. Several are known from North America. They are all quite minute. *Pediculoides graminum* Reuter and *P. ventricosus* Newport are quite common in many parts of the world, especially in grain growing regions. Their biology as well as that of several others is well known.

A number of species are known to attack plants and scale insects, as do the Tarsonemidae. Some seem to transmit disease as *P. graminum* and its close relation with bud-rot of carnation. *P. ventricosus* and others are frequently found associated with various dipterous, hymenopterous, coleopterous, and other insects upon which the mites are often parasitic. Where this habit centers about an injurious insect the mite can be considered distinctly beneficial. From this state the mite often assumes a marked economic aspect from certain injuries which they may cause. *P. ventricosus* has long been known from standing and cut grain where its parasitism upon the joint worm and the grain moth larvae had brought it into good standing as a beneficial species.

Grain straw was frequently used for filling mattresses and in packing of pottery and if not thoroly cleaned it often carried numerous mites into these several industries. Harvesters in the field, workers in straw mattress factories, those sleeping on straw mattresses, workers in pottery packing rooms, and others coming in contact with straw often experienced very severe outbreaks of an irritating dermatitis on all parts of the body. After some research the beneficial parasite was found to have the faculty of becoming extremely noxious to man. *P. graminum* also possesses this habit.

Pediculoides ventricosus Newport
Trans. Linn. Soc., XXI, 1853, p. 95

These mites are quite minute and have the characters of the family. The eggs are not deposited but carried within the abdomen of the female where in time they will hatch. Development through the several metamorphoses to maturity occurs before the mite issues from the abdomen of its mother. They may even issue after the death of the latter providing development has proceded far enough. Males are seldom taken and parthenogenesis is common.

The species is common in Ohio and thruout North America altho it does not seem to occur as frequently as formerly. It is my opinion that many cases of so-called "chiggers" are attributable to this species and not to Trombidiid larvae.

Suborder ATRACHEATA

Included here are a large number of mites of very diverse habits. The adults are always octopod and the legs are supported by chitinous ridges or epimera; there are no tracheae present; the small, usually three-segmented palpi are more or less fused to the base of the rostrum.

Section BRACHYPODA

But one family of one genus is included in this division. The three segmented legs are quite rudimentary and the body vermiform. Transverse annulation give the appearance of segmentation. These mites are known to occur in the hair follicles and sebaceous glands of some vertebrates thus giving the name of "follicle mites."

Family Demodicidae

This family and its one genus Demodex have the above characters. Several domestic animals and man are hosts to the several species. Many points of the biology are still uncertain. The very

minute, white eggs are spindle shaped and deposited in the pustule inhabited by the parent. A small white hexapod, apparently apod, larva hatches. The legs appear as rudimentary tubercles. After a short time the larva molts and an octopod nymph appears. It greatly resembles the adult. It undergoes two more molts before maturing. Adults measure about .4 mm long by .04 mm wide. They and the nymphs are free to move about over the body from follicle to follicle and thus distribute the infestation. Living only on warm blooded animals there may be a number of generations each year.

Most domestic quadrupeds and some rodents are subject to attack. Poor bodily sanitation favors an infestation. On man the angles of the nose and similar places often slighted in bathing serve as places of establishment for the mites. Their attack on all hosts results in a small whitish pustule at the base of the hair or including the entire sweat gland. These often appear as "blackheads" and among certain classes of people the latter may be caused by mites, altho "blackheads" usually have a different origin.

Various workers have held *Demodex* capable of transmitting certain human diseases such as leprosy, cancer, and certain forms of eczema. Altho there is a possibility of this occurring, there is, to my knowledge, no proof of its certainty. Cleanliness is the best safeguard against an infestation. Sulphur ointments for man, and cattle dips for livestock are the usual treatments.

I have records of two species from Ohio but feel that a thoro canvas of our clinics would also reveal *Demodex folliculorum* Simon, the common follicle mite of man, since this species has a cosmopolitan distribution. Those of other domestic animals may also occur in the State.

Demodex canis Leydig
Ann. Nat. Hist., XIII, 1844, p. 75

This is a cosmopolitan species on the dog. I have several records from about Chillicothe. It very likely is generally distributed thruout the United States.

Demodex bovis Stiles
Can. Ent. XXIV, 1892, p. 286

I have several records of this species from Ohio, and it has been reported from a number of places in North America and Europe.

Section EPIMERATA

In these mites the body is short and stout and the legs are more than three segmented. It includes six families which usually comprise the superfamily Sarcoptoidea.

Family **Tyroglyphidae**

This family has the integument usually smooth; the tarsi without stalked suckers; and the adults never parasitic. It does not comprise many species but some of these are of considerable economic importance. Michael has given us a beautiful monograph of the British forms.

Nearly all the species are oviparous, scattering the rather large eggs about in whatever material the mite happens to be in. Upon hatching milky white hexapod larvae appear. These molt, shortly to appear as octopod nymphs which resemble the adults. Hence forth the mites may, and in many species do, pursue one of two courses to maturity. In one of these there is nothing unusual since, passing thru several molts, an adult appears. All stages in this course are active.

The other course brings us to a hypopal stage or Hypopus which is another of those interesting adaptations often found in biology. It has been the cause of many new descriptions and consequent taxonomic confusion, many false impressions of beneficial parasitism, etc., but is now known to be but a quiescent stage supplanting the normal second nymphal ecdysis. In this stage the mite bears rudimentary legs poorly adapted for walking and nonfunctional mouthparts. It clings to its insect carrier by means of a group of suckers on the posterior ventral surface. This separates them from the nymphal Uropodidae which are attached by a pedicel. So many of these hypopi cling to an insect at times that the latter may die thru its efforts to move about.

The causes bringing about the hypopus are not known. It does serve as a means of tiding the species past a dry season or failure of food but may occur when these factors are normal. It also serves as a means of distribution. All individuals of species having a hypopal stage pass thru it before maturing. Some species enter a similar stage but do not attach to insects. A nymph usually appears from the hypopus after which maturity is reached. Some species show a marked sexual dimorphism. The male is the smaller. This life cycle is that passed thru by nearly all the species in the family except for variations determined by food supply and climatic factors. Where the food material consists of

stored food products, as it often does, there may be a number of generations a year, while out-of-doors there are fewer.

Of the fifteen or more genera included in the family, five are now known to have representatives in Ohio. The genus *Glyciphagus* has the mandibles chelate; the palpi normal and without prominent bristles; the dorsal integument more or less granular, which character separates it from allied genera; the tarsal claws very weak; and some of the body hairs slightly feathered.

These mites are commonly called "sugar mites" from their frequent occurrence in this material, altho they are often found in other grocery goods, stored grains and seeds, animal products, etc. Those finding employment in buildings infested with these mites often suffer from an irritation known as "grocer's itch" due to these mites wandering about on the body, altho they are never parasitic there. Species of this genus and others allied to it have been reported from the intestinal tract and its contents, but this seems quite doubtful.

Glyciphagus domesticus deGeer
Mem. Hist. Ins. VII, 1778, p. 88

Adults are a dirty white to pale brown color and .4 mm long. The abdomen and cephalothorax are closely fused; the dorsal hairs are finely feathered and of but one kind; there is no conspicuous hair on the 4th segment of legs I and II but two smaller hairs are present on this joint. The species is recorded from stored grain in several Ohio localities. It is generally distributed in the United States and Europe and reported from a wide variety of dried animal and vegetable products.

Glyciphagus robustus Banks
Tech. Bul. 13, U. S. D. A. Bur. Ent., 1906, p. 13

This is a smaller species than the preceding being but .25 mm long. It has a long hair on the 4th segment of legs I and II. The type material was collected in seeds at Leetonia, Ohio. It is not as common as the preceding species.

The genus *Histiostoma* contains those mites with a smooth but slightly undulating dorsum; tarsal claws distinct; no prominent feathers or long hairs on the body; the mandibles not chelate; and the distal palpal joint enlarged and bearing two divergent bristles, which character is quite distinctive of the genus. The species are apparently scavengers in a wide range of decaying animal and

vegetable matter. There is a hypopal stage on insects. A European species, *H. berghi* is reported as parasitic in the egg capsule of a horse leech in Denmark.

Histiostoma americana Banks
Tech. Bul. 13, U. S. D. A. Bur. Ent., 1906, p. 11

This is a small species being only .2 mm long. It is very common in Ohio. I have taken it from numerous dead insects, their larvae and pupae, and in decaying vegetation. I do not believe it directly causes the death of any insects, altho fungi and bacteria on the body of the mite may indirectly affect the insect. The species is widely distributed east of the Mississippi River.

Rhizoglyphus differs from *Histiostoma* in having the mandibles chelate; the palpi normal and without bristles; a clavate hair on the base of tarsi I and II; the abdomen and cephalothorax separated by a suture; and the latter clothed with but two long distinct bristles besides the frontal pair. These also feed in various forms of decaying animal and vegetable matter, and I have taken them in large numbers from dead insects. A hypopal stage occurs on insects.

Rhizoglyphus hyacinthi Boisduval
Ent. Hort., 1867, p. 8

Adults and nymphs range from milky white to almost brown in color, often tinged with pink. Mature females are about .7 mm long and males about .35 mm long. Tarsus I, while it is not more than twice as long as broad, bears a large spine close to the sense hair.

This species is of considerable economic importance because of its common occurrence in the bulbs or tuberous roots of many of our common greenhouse and garden plants. Reproduction is rapid and spread easy. Nearly every importation of bulbs, no matter from what country, carries this species. It is nearly always associated with certain bulb and tuber rots and has been considered the active agent in transmitting the rot-producing organisms. Flies and other insects breeding in the rotting bulbs carry numerous hypopi of this species.

Where the bulbs are perfectly dormant a partially effective remedy is to dip them in a .25 percent nicotine sulphate solution heated to not above 50 degrees C. Precautionary measures are most satisfactory. No soft or rotten bulbs should be planted and

proper cultural care should be given the plants. All decaying bulbs and other vegetation should be burned since these will harbor mites.

The species is common in many parts of Ohio attacking various bulbs and roots. It is common thruout the United States.

Rhizoglyphus phylloxerae Riley
6th Missouri Rpt., 1874, p. 52

This is a much more common species than the preceding and differs from it in having no spine near the sense hair on tarsus I and the abdominal bristles are much shorter than the body width. Adults measure about .8 mm long. They vary in color from milky white to pale brown.

I have taken it from a large list of decaying plants and insects in various parts of the State and have reared it successfully on agar preparations supporting a bacterial growth. Under like conditions of decay it is reported from many places in the United States east of the Rocky Mountains.

Tyroglyphus differs from *Rhizoglyphus* in having four long distinct bristles arranged in a row on the cephalothorax and that tarsi I and II are about twice as long as the preceding joint. Hypopi occur on insects. The group includes what are commonly called the cheese mites and flour mites, *T. siro,* which is cosmopolitan; the mushroom mite, *T. lintneri,* and others feeding in stored animal and vegetable products. They may cause considerable loss. These as well as other species of similar habits seem to be best controlled by removing and destroying all infested material and thence forth pursuing a strict policy of sanitation. Where possible to raise the room temperature to 120 degrees F. for a period of half an hour or more all mites properly exposed will be killed. The practice cannot be followed with seeds for planting or any material that will be injured by the heat.

Several species in this genus are reported from scale insects, altho there is no evidence that they were feeding upon live scales.

Tyroglyphus lintneri Osborn
Science, 1893, p. 360

This small, dirty white species is about .35 mm long. It has no spine-like bristle near the middle of the tarsi; six or more of the terminal abdominal bristles are very long; the body bristles are pectinate; the cephalothorax and legs are normally proportioned.

The type is described from mushrooms and it has since been found to be an important factor in the success or failure of this crop. Decaying matter, both animal and vegetable, also serve as food for this species. Sanitation, especially the removal of decaying material, is the most satisfactory control. I have taken the species on dead grasshoppers at Chillicothe. It is widely distributed in the United States.

Tyroglyphus siro Linnaeus
Syst. Nat. 1758, I, p. 616

Adults resemble the preceding to a great extent. They are about .6 mm long. This species differs primarily in that none of the body hairs are as long as the body and none of the longest are pectinated. Tarsi in the female are shorter than or equal to third segment in length. As already noted this species is cosmopolitan in distribution and infests various stored products.

The genus *Monieziella* contains a few species of quite beneficial mites since they are predaceous upon various scale insects. I believe I have evidence that they also prey upon Tetranychid and Eriophyid mites. The genus differs from *Rhizoglyphus sp.* in having only fine hairs on the tarsi instead of stout spines. Michael records the hypopi from various insects. There are but four or five species known from this country and two are recorded from Ohio.

Monieziella angusta Banks
Tech. Bul. 13, U. S. D. A. Bur. Ent., 1906, p. 23

This species measures about .3 mm long by about .1 mm broad, and has no cephalic or humeral bristles. It is almost hyaline in color often slightly tinged with green. I have taken it from the common Eriophyid witches brooms on *Celtis occidentalis*. The gall mites were quite numerous and in some form may have served as host to this species. The latter were not common. It is also recorded from *Aspidiotus sp.* and *Chionaspis sp.* and other scales in the United States.

Monieziella longipes Banks
Tech. Bul. 13, U. S. D. A. Bur. Ent., 1906, p. 23

This species differs from the above in having cephalic and humeral bristles present; the body scarcely twice as long as broad; and the tarsi nearly as long as the preceding joint. Adults are about .3 mm long and usually milky white in color with a slight tinge of green.

I have material from *Quercus palustris* which was heavily infested with *Paratetranychus yothersi* McG. There were no scales present and, altho I observed no feeding, it would appear that, if *M. longipes* is predaceous, the spider mites in some form were serving as host. It is recorded from Florida on *Mytilaspis sp.*

Superfamily Sarcoptoidea

Five families of parasitic mites comprise this superfamily. The family Listrophoridae contains about seven genera, including a number of species closely related to the bird mites. They are usually to be found upon the smaller mammals, to the hairs of which they cling by a peculiarly modified leg structure. This has given them the common name of "hair clasping mites." Their food consists of the hairs of the host. They have been but little studied in this country.

The Analgesidae, or "bird mites," live as commensals among the feathers of birds. Some species have a very wide distribution and there are undoubtedly many species awaiting discovery in Ohio. They feed upon the feathers, epidermal scales, etc., and can be considered an asset to the host since they aid in keeping its body clean. They can be collected from dried skins since they do not leave the host at death. There are many genera and a very large number of species known from all parts of the world.

The family Cytoleichidae includes but a few species of mites in two genera. They are usually found in the air passages and air cells of birds where they may cause asphyxia resulting in death of the host. It is thought they gain access while the bird is eating. But little study has been given the group. Some species are viviparous.

Family Canestrinidae

Four genera of small, soft-bodied species of predaceous mites are included in this group. Some are thought to be parasitic upon various insects. The body is entire and the legs are short. The mouth parts are small and simple. Their life history has been but little investigated. One species is known from Ohio.

In the genus *Hemisarcoptes* the mandibles are shear-like and the legs terminate in fleshy clasping organs.

Hemisarcoptes malus Shimer
Trans. Amer. Ent. Soc., I, 1868, p. 368

Canestrini and Kramer give but this one species for the genus in "Das Tierreich" in 1899. Shimer described it from Ohio in 1868 as *Acarus malus* stating that it was predaceous on the eggs of *Lepidosaphes ulmi* L. I have not taken it.

Family Sarcoptidae

This family includes a large number of species that are all parasitic, burrowing in the skins of various animals. In man and the domestic animals, and very likely in other hosts, the attack causes great irritation occasionally resulting in death if relief is not given. The attack is usually evidenced by the appearance of vescicles, palpules, or pustules on the skin which may become badly ulcerated. The symptoms on various hosts, altho infested with the same species, may differ considerably. The hair or wool usually falls away from the affected portion leaving the scurfy-like skin beneath. This irritation justifies their common name of "Itch mite" and the symptoms as "mange" or "scabies."

The species are nearly always white and the body semi-globose and entire, transversely striated above, carrying but few hairs or sharp spines and bristles, and about .25 mm long. The legs are short and terminate usually in a sharp claw and a pedicellate sucker. When these are wanting a long hair terminates the tarsi. The beak is free and prominent. The palpi are small, three segmented, and lie close to the sides of the rostrum.

Altho the symptoms may vary, the life cycle is quite similar in all species and will be given but once. Since mammals most frequently serve as hosts the repetition of generations is continuous thruout the year being but little influenced by external conditions. Transmission from host to host is by direct contact. Various controls have been recommended usually incorporating sulphur or some non-injurious oil or both as the active agent. A 3 percent carbolized sweet oil preparation or any suitable petroleum derivative such as kerosene or crude oil will be found effective for local infestations on all animals and man. Bodily sanitation is not to be overlooked in combatting an infestation.

The female burrows into the skin of its host, depositing its eggs along the walls of the burrow. The number of these varies from 10 to 30 or more. They hatch in three or four days, the young appearing as small, white, hexapod larvae. These may begin to make their own burrows thru the walls of the parent burrow, or they may gain access to the surface and make their way to a new location and burrow into the skin anew. Since the burrows are usually near the surface the epidermis soon loosens and appears as a scaly surface variously altered by excretions from the burrows. After about a week the mites molt and appear as

octopod adults. Mating takes place shortly and the female begins depositing eggs. After completing this process she dies near the end of her burrow.

In Ohio there are eight species distributed in four genera. In *Notoedres* the anus is on the dorsum and the third pairs of legs in the male have apical suckers.

Notoedres cati Hering
N. Acta Ac. Leop., XVII, Ser. II, 1838, p. 605

This is the common mange mite of the cat. It is also reported from the rabbit. I have several reports from Ohio and the species is considered as cosmopolitan with its host.

In the genus *Sarcoptes* the anal opening is ventral. The mandibles are chelate; the tarsal pedicel is unjointed, with suckers on legs I and II; all the legs are short as is also the body. Nearly all domestic animals harbor a species of this genus and some mites have more than one host.

Sarcoptes equi Gerlach
Kratze, t. 2, 1857, p. 72

This species is cosmopolitan on the horse and its near relatives. Occasionally it is recorded from man. Several occurrences are recorded from Ohio. Dipping treatments for general infestations are quite effective.

Sarcoptes canis Gerlach
Kratze, t. 2 and 3, 1857, p. 141

This species is cosmopolitan with the dog and its near relatives with man occasionally serving as host. It is fairly common in Ohio.

Sarcoptes scabiei de Geer
Mem. Hist. Ins., VII, t. 5, 1778, p. 94

This species is cosmopolitan and is the one usually found infesting man altho domestic animals are sometimes attacked. Several cases have come to my attention in Ohio. Among the poorer, but especially all uncleanly classes, this species is most commonly found to cause skin diseases. Transmission of more infectious diseases is suspected though to my knowledge definite proof is lacking. The precaution of bodily cleanliness is to be advised for freedom from this mite.

Sarcoptes suis Gerlach
Kratze, t. 3, 1857, p. 137

This mite causes mange in hogs. It is cosmopolitan with its host. It is known from Ohio. An oiler in the hog lot is usually sufficient to keep the stock free of this species.

Cnemidocoptes differs from *Sarcoptes* in having suckers on all the legs. The species are all parasitic on birds.

Cnemidocoptes mutans Robin
Bul. Soc. Moscow, XXXIII, 1869, p. 184

This is the common "scaly leg" or "bumble foot" mite attacking the feet of poultry. It is cosmopolitan with its host and is known from several Ohio localities. Slight exudations of blood often give the swollen legs a red or brown appearance. Distribution is usually slow. Several applications of the oil treatment by dipping the feet of the birds into a pan of the material is usually quite effective.

In *Psoroptes* the tarsal pedicels are jointed and the mandibles are styliform.

Psoroptes bovis Gerlach
Kratze, t. 5, 1857, p. 114

This species is cosmopolitan on cattle and is occasionally found on man and other animals. Several records are known from Ohio. There are about 20 generations a year. Dipping in crude petroleum is effective against both mites and eggs.

Psoroptes ovis Hering
N. Acta Ac. Leop., XVIII, Ser. II, 1838, p. 594

Like the others, this species is cosmopolitan with its hosts, the sheep and goat. There are many records of its occurrence in Ohio. Lime-sulphur dip or nicotine and sulphur dips have been found quite effective. Hand treatment is not practical.

Suborder TETRAPODA

A large number of small, vermiform, phytophagous mites comprise this suborder. They differ from all other mites in having but four legs when mature. These are near the anterior end. It includes but one family.

Family Eriophyidae

The position of these mites in the phyllogenetic tree was long an uncertainty. They have been considered as an abberant development of the Tarsonemidae, the Sarcoptidae, and the

Tetranychidae by various workers. Dr. Ewing has recently allied them with the Tetranychidae considering the family Phytoptopalpidae as the connecting link.

The presence of the "gall mites" or "blister mites" is usually evidenced by various malformations and discolorations of the buds, leaves, flowers, or fruits. These show various crinklings, blisterings, pouches, pockets, erineums or felt-like masses of hairs, marginal rollings, brownish discolorations, etc. All formations have openings in them and are frequently lined with fine fleshy trichomes or hairs. Buds may be merely stunted or enlarged in growth and show only as tangled masses instead of the orderly foliations. Witches brooms frequently develop as in the case of the familiar one on hackberry. Various coxcomb-like floral growths are frequently galls of some Eriophyid. Much confusion between diseased tissues and mite and insect galls has occurred.

Some actively growing tissue is usually the base of attack and the interesting biological process of adventitious cell proliferation into regular and almost constant structures occurs. Collections of the same galls at different stages of development has led to confusing new descriptions. Many descriptions are based upon the galls only and since these are not recognized by modern taxonomists more confusion often results. Some workers have considered each host as supporting a specific mite fauna and described new forms accordingly. Altho I have not studied all the species in detail, I am of the opinion that the same mite species does occur on various host species of the same or nearly allied genera and altho the galls may vary in form the causative organism is the same. Because of the wide interchange of fruit, shade, and forest trees between this country and others, especially Europe, it scarcely seems advisable to use the breadth of an ocean to establish new species of mites that occur upon trees.

The adults hibernate beneath bud scales, in bark crevices, and I believe also in the dried galls on fallen leaves. I have frequently noticed the appearance of the galls first on the leaves of the lower twigs and the gradual spread upward until the entire tree may show a general infestation.

The mites appear in the spring when the leaves are opening. The eggs, which are quite large for the size of the parent, are laid singly, either on the leaf surface or within the galls. They are slightly spheroidal in shape and nearly white in color. They hatch in about a week and the young are at first all but helpless and lack tarsal appendages. The first molt, taking place in a few days,

finds the mite with minute claws. Three more molts bring it to maturity. A brief resting period precedes each molt. A number of generations succeed each other during the season of plant growth and when fall and cooler weather comes the mites seek hibernation quarters. Adults measure about .15 mm long.

Nine genera are included in the family and these are easily divided into two subfamilies. I have preferred to follow Nalepa in his consideration of the species and have omitted several species recorded from Ohio by other workers because of inadequate descriptions. I may appear to be self-contradictory in presenting the Ohio species since host is apparently used for specific differences, but space will not permit detailed taxonomic characters.

Subfamily **Eriophyinae**

In this group the number of dorsal and ventral semi-annulations is the same or nearly so. These annulations are not segments. They are of considerable importance in separating the species.

The genus *Eriophyes* includes about 150 species of which I record the following 18 from Ohio.

Eriophyes aenigma Walsh
Proc. Amer. Ent. Soc., VI, 1868, p. 227

Sears reports this species from *Salix longifolia.* The terminal bud develops into an irregular mass of yarn-like growths. During July it was fairly common about Cedar Point, Ohio. It is reported thruout the northern United States and southern Canada. There seems to be no satisfactory description of the mite.

Eriophyes brevitarsus Fockeu
Rev. Biol. Nord. France III, 1890, p. 3

This is a fairly common species causing pouch galls on *Alnus sp.* in Europe and on *Betula sp.* thruout the northern United States and southern Canada. Sears reports it from the latter host at Cedar Point, Ohio.

Eriophyes eucricotes Nalepa
Anz. Ak. Wien., XXIX, 1892, p. 128

This is a very common species on *Lycium sp.* thruout Europe and North America. In southern Ohio it is difficult to find a host not infested and often so heavily as to cause complete defoliation. The circular pouch-like galls open on the lower surface and are

filled with a spongy mass of tissue thru which the mites work. The latter are orange-red in color and may frequently be found outside the gall.

Eriophyes filiformis Nalepa
N. Acta Ac. Leop., LV, t. 1, 1891, p. 374

This is a fairly common species on *Ulmus* sp. in Europe and North America. The pouch-like galls have a constricted neck and open on the lower surface. They are quite elongate and slightly flattened, and are filled with numerous hyaline trichomes among which a few red ones are always to be found. The mites are pale yellow and very slender.

Eriophyes fraxinicola Nalepa
S. B. Ak. Wien, XCI, t. 3, 1890, p. 48

This species is quite common in Europe and is frequently met with on *Fraxinus spp.* in this country. It causes elongate, pouch or nail galls opening on the lower surface. The trichomes within arise in scattered tufts. A few fleshy ridges project the entire inner length of the gall. The mites are pale yellow often tinged with pink.

Eriophyes fraxinivorus Nalepa
Anz. Akad. Wiss. Wien., XLVI, 1909, p. 17

This is a common species in Europe and North America on *Fraxinus spp.* deforming the buds and flowers and causing irregular, minutely foliose masses which after drying may persist on the tree thruout the ensuing winter. In this country it is most common on *F. americanus* and I have numerous records of it from Ohio. It causes but little apparent injury to the tree altho the nearly white mites are usually very numerous.

Eriophyes goniothorax Nalepa
S. B. Ak. Wien., XCII, t. 8, 1889, p. 140

This species is recorded from *Crataegus sp.* in Europe and I have what I believe to be this species from tightly rolled marginal galls of *Crataegus spp.* in southern Ohio. It is quite common.

Eriophyes laevis Nalepa
N. Acta Ac. Leop. LV, t. 4, 1891, p. 383

This species causes small pouch galls on either surface of *Alnus spp.* in Europe and North America. I have it from *Alnus rugosa* in southern Ohio. The galls are sharply conical below and

somewhat rounded above with the opening in the lower projection. A few mites were crawling about on the leaf surface. They are orange in color.

Eriophyes padi Nalepa
Anz. Ak. Wien., XXVI, 1889, p. 162

This mite causes the numerous elongate pocket galls on *Prunus spp.* in Europe and North America. I have collected it often on *Prunus serotina* in southern Ohio. They usually have a pointed apex and a strongly constricted neck. Numerous loose, irregular trichomes arise from the inner walls. They do not taper as is the usual case with these structures. The mite varies from milky white to pale orange in color.

Eriophyes phloeocoptes Nalepa
S. B. Ak. Wien., XCI, t. 6, 1890, p. 54

This is the common "Plum-leaf gall mite" of Europe and North America. The mites cause a marked discoloration of the leaves, which become brownish and rather wrinkled. The mites usually work on the lower surface. Their attack frequently results in premature defoliation and an accompanying loss of fruit. The control recommended for the next species is also effective against this one. It is fairly common in Ohio.

Eriophyes pyri Pagenstecher
Verh. Ver. Heidelberg I, 1857, p. 48

This is the common "blister mite" of pear and apple and seems to be cosmopolitan in its distribution. As the leaves unfold in the spring they may show brownish blotches. At first they are most conspicuous on the upper surface but as the season advances the tissue dies and becomes brown on both upper and lower surfaces. These usually mark a very flat blister-like structure opening on the lower surface. In this the mites are active but occasionally they are found on the outside. Newly formed galls are usually quite succulent. Occasionally they may attack the fruit. The species is known from close relatives of the pear and apple also.

Partial defoliation with consequent decrease in crop yield follows attack by this mite. The most effective control yet devised is a lime-sulphur spray applied at the time the buds are swelling in the spring, but after they are open it is too late. Summer spray with either lime-sulphur or oil emulsions are not effective.

Eriophyes quadripes Shimer
Trans. Amer. Ent. Soc., II, 1869, p. 319

This species causes the small red or green pouch galls on soft maples. They are quite irregular in shape. No trichomes appear except at the neck. The inner surface is ridged by irregular, fleshy protuberances. The size varies considerably. No galls have been found containing more than one adult but this is probably to be explained by the recentness of the infestation. Little injury results to the host, nor have I seen any degree of defoliation from the attack of this mite. All sections of Ohio are infested.

Eriophyes salicinus Nalepa
Denkschr. Akad. Wiss. Wien, 1899, LXVIII, t. 5, p. 213

This species causes capsule galls on *Salix sp.* in Europe and North America. The galls are small, red or green in color, irregular in shape, and filled with fine trichomes. Scarcely a specimen of *S. nigra* in southern Ohio is free of this species.

Eriophyes tetanothrix var. laevis Nalepa
Denkschr. Akad. Wiss. Wien. LXVIII, 1899, p. 215

This species causes pocket galls on *Salix* sp. in Europe and North America. They are rather composite structures with elongate, irregular openings in the lower surface. Fleshy trichomes line the galls. It is common on *S. nigra* about Chillicothe.

Eriophyes thujae Garman
App. 12th Illinois Rpt., 1883, p. 138

This species occurs on various horticultural varieties of *Thuja occidentalis.* It may be synonymous with a European species. The only evidence of its presence is a yellowish discoloration of the terminal growth which may terminate in death. It is widely distributed in North America. Summer strength lime-sulphur is partially effective in controlling this mite.

Eriophyes tiliae Nalepa
S. B. Ak. Wien., XCI, t. 2, 1890, p. 46

Sears reports *E. abnormis* Garman from *Tilia americana* at Cedar Point. I believe that this name is synonymous with *E. tiliae* Nal. It causes small pouch galls on the upper surface of the above host and on *Tilia spp.* in Europe.

Eriophyes tristriatus Nalepa
Anz. Ak. Wien, XXVI, 1889, p. 162

This species causes pouch galls on *Juglans sp.* in Europe. I have taken what appears to be this species on *Juglans nigra* in southern Ohio. The mites were not associated with galls altho typical galls were present on the tree.

Eriophyes ulmicola Nalepa
Anz. Akad. Wiss. Wien., 10, 1909, p. 117

This mite causes the pouch galls so common on *Ulmus americana* and *U. fulva* in North America. It is common in Ohio. The galls are dark green in color, have a pointed apex, and a constricted neck. They are densely packed with fine trichomes. The opening is on the lower surface. Mites vary from milky white to orange in color.

Subfamily **Phyllocoptinae**

These mites have at least twice as many ventral semi-annulations as dorsal ones and the cephalothorax frequently projects beyond the rostrum. I have five species in two genera from Ohio.

The genus *Phyllocoptes* has the dorsum evenly curved and the end piece of the abdomen indistinctly separated from the rest. One species, *P. schlechtendali* is of considerable importance from its attack on pear.

Phyllocoptes aceris Nalepa
N. Acta Ac. Leop., LXI, t. 4, 1894, p. 313

This species causes the common nail-like galls on *Acer spp.* in Europe and North America. It is common on *Acer saccharum* thruout southern Ohio. The galls are sharply pointed and open on the lower surface. Within there are longitudinal ridges frequently extending a short distance thru the opening. The mites are orange in color.

Phyllocoptes magnirostris Nalepa
Anz. Ak. Wien., XXIX, 1892, p. 128

This species causes small pocket galls on *Salix fragilis* in Europe and North America. The galls are red or green thruout. The neck is constricted slightly and small fleshy trichomes fill the interior. It is a common species in southern Ohio.

Phyllocoptes mastigophorus Nalepa
N. Acta Ac. Leop., LXI, t. 3, 1894, p. 308

This species occurs on *Ulmus spp.* in Europe and North America. It does not seem to form galls. I have taken it abundantly from beneath the webs of *Tetranychus telarius* on *Ulmus ameri-*

cana. It can make its way thru and over the webs of the latter without any apparent difficulty. It may be responsible for some of the discoloration of *Ulmus spp.*

Phyllocoptes toxicophagus Ewing
Proc. Ia. Acad. Sci., XXIV, 1917, p. 324

This species causes the numerous irregular green or red pouch galls on the leaves of *Toxicophagus toxicodendron* or poison ivy. The gall cavity is much branched and filled with trichomes. There is but a slight constriction on the lower surface at the gall openings and, since the trichomes often do not choke these, the activities of the mites may be easily studied. The mites are very common. Their distribution is general with the host.

In the genus *Anthocoptes* the terminal piece of the abdomen is plainly separated from the rest of the body.

Anthocoptes platynotsus Nalepa
Anz. Ak. Wien. XXIX, 1892, p. 191

This species is common on *Cornus spp.* in Europe and North America. I have taken it on *Cornus florida* in southern Ohio. It causes no deformities of the leaves. The orange colored mites were taken on the lower side of the leaves in large numbers.

CONCLUSIONS

In presenting this introductory study of the mite fauna of Ohio I have but hoped to begin a work that I trust others will aid me in continuing. There are few acarologists in our country and but few more abroad. The subject offers a very broad field for taxonomic and biological research. The student in search of problems will find acarology replete with them. Every species is deserving of painstaking investigation of its biology and relationships. The technique is but poorly developed and each student should make an effort to improve upon it that this science may become more certain in the results which are achieved.

In an effort to record all the species actually known to occur within the State, I can present 127 species. Some of these are new to our national fauna and many are new for the State altho their presence might have been suspected. A more accurate knowledge of the distribution of these species is therefore available.

Of these species, 28 are of direct economic importance to us because of their actual or potential capacity to cause losses to human industries. I have appended to the discussion of each species of this nature the most effective practical control thus far known and have attempted to so index this volume that such information may be readily accessible to those interested in these data.

The reader has probably noticed the complete lack of keys. As in any work of this character these might have been constructed, but I have felt that since I have by no means a complete list of our Acarina and that many genera contain but one, or at most a very few species as at present known it would be of little value and would but lead to confusion when later material is discovered. I have endeavored to present the major taxonomic characters so as to enable the student to ascertain whether the species in hand is the one here recorded.

In the course of my studies I have collected upwards of fifty species that appear to be new and many more that lack of time has prevented me from placing specifically. Other tasks permitting, I propose to continue the study of our acarid fauna and from time to time present such contributions as these studies may make possible.

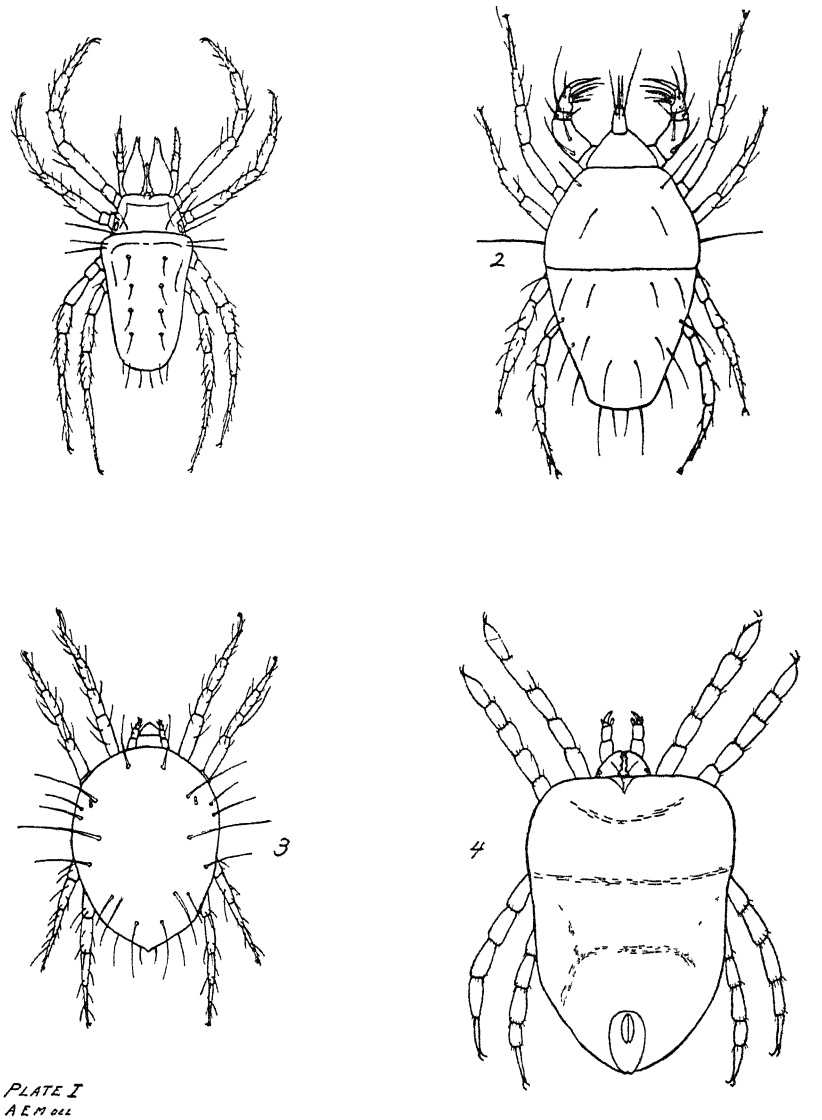
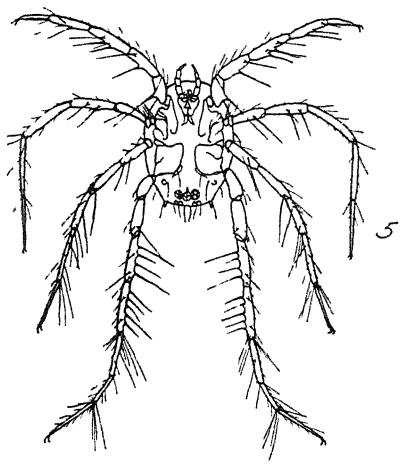
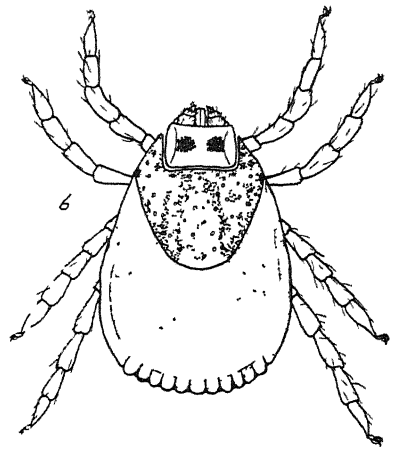
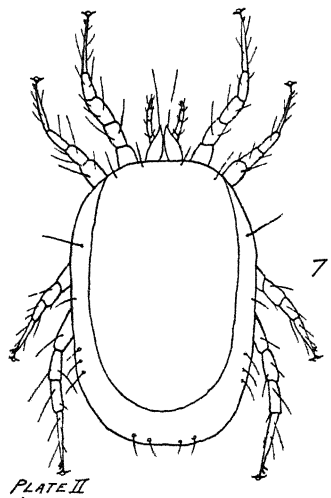


Fig. 1. Rhagidia pallida Banks. (After Banks) X 65
Fig. 2. Cheyletus seminivorus Packard. (Orig.) X 100
Fig. 3. Tetranychus telarius Linnaeus. (After Ewing) X 90
Fig. 4. Eutrombidium trigonum Hermann. (Orig.) X 25







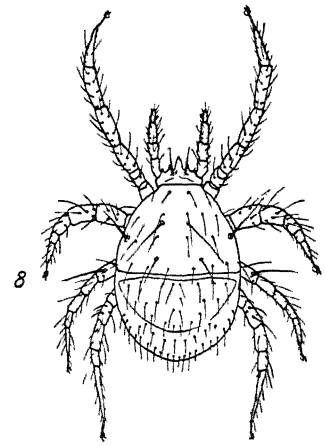
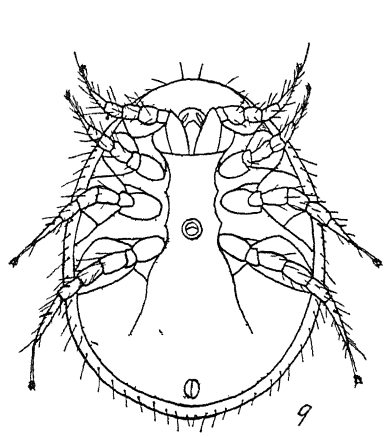
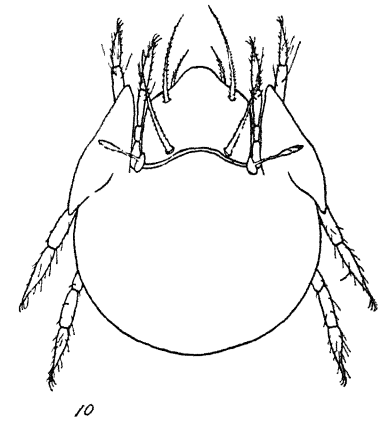
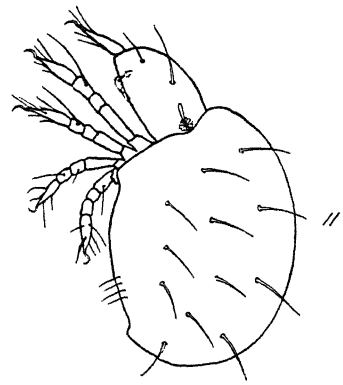


PLATE II
A E M DEL

Fig. 5. Unionicola crassipes Muller. (After Wolcott) X 25
Fig. 6. Dermacentor variabilis Say. Female. (Orig.) X 15
Fig. 7. Dermanyssus gallinae Redi. (After Banks) X 85
Fig. 8. Parasitus inaequalis Banks. (After Banks) X 35







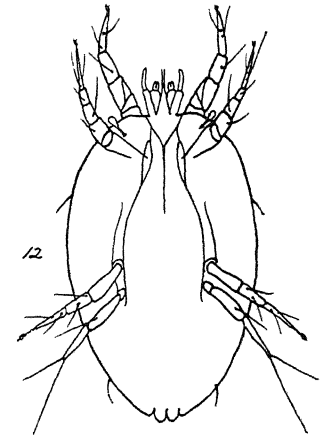


PLATE III
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Fig. 9. Uropoda illinoisensis Ewing. (Orig.) X 95
Fig. 10. Oribata robusta Banks. (After Ewing) X 65
Fig. 11. Ginglymacarus dasypus Duges. (After Ewing) X 60
Fig. 12. Tarsonemus pallidus Banks. Female. (After Banks) X 350

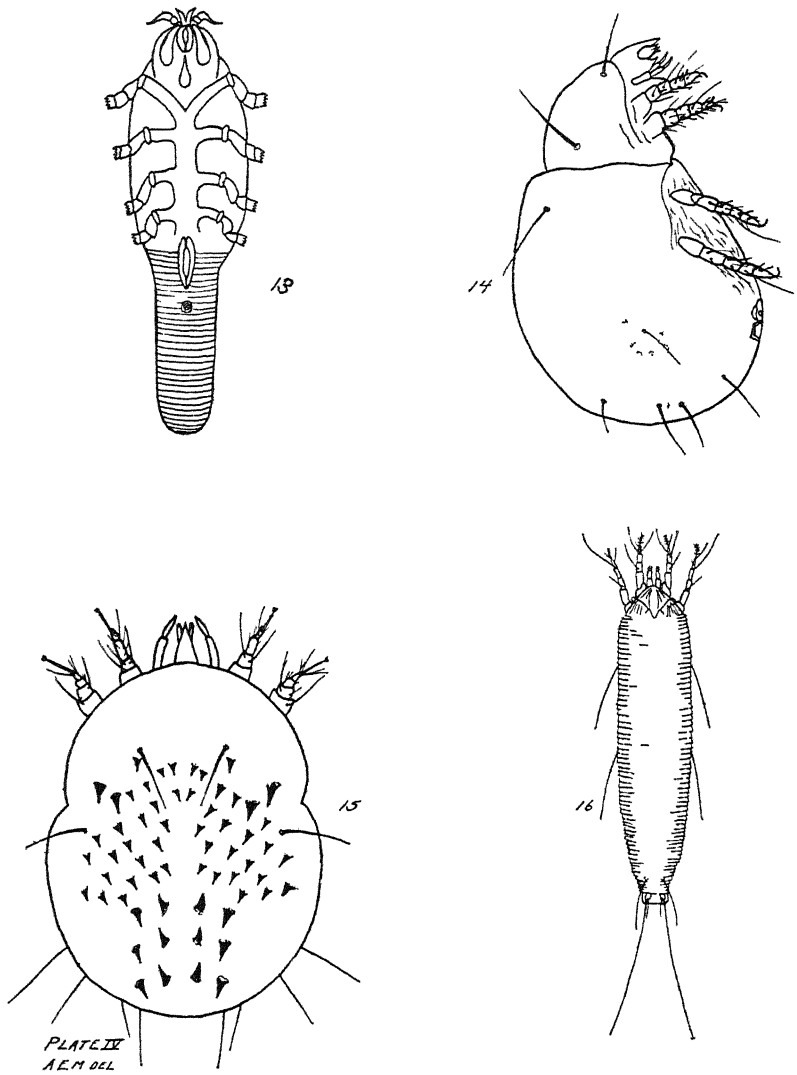

Fig. 13. Demodex folliculorum Simon. (After Banks) X 200
Fig. 14. Rhizoglyphus hyacinthi Boisduval. (After Banks) X 100
Fig. 15. Sarcoptes scabei de Geer. (After Banks) X 300. (Female)
Fig. 16. Eriophyes pyri Pagenstecher. (After Nalepa) X 425

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